Repeatable Solutions: the Case of Elderly-Care Provision.

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"*Seldom, if ever, should a person model the specific situation of interest but, instead, should model the family of systems to which the specific one belongs*" (Forrester, 2013)

ABSTRACT. *While many of the system dynamics projects and models reported concern one-time initiatives to tackle specific challenges, a large proportion also cluster into classes of common topics. Furthermore, many real-world situations are similar enough that it should be possible to deploy the* same *model repeatedly, greatly accelerating deployment of model-based solutions and acceptance of the method. One such case concerns the challenge facing 136 Local Authorities in England and Wales, for whom new legislation imposes additional responsibilities to finance the care of frail elderly people who cannot themselves afford that care. Those responsibilities also include minimising costs to local tax-payers and ensuring a viable market for the provision of Residential Homes and Nursing Homes. All Authorities must develop plans during 2015, so modelling-based assistance on a case-by-case basis is quite infeasible. However, since the main elements of the Care-Home system are identical to all such Authorities, it is possible to develop a single planning solution that can be rapidly rolled out across the entire sector. Since near-identical challenges for very similar organisations arise in all domains, it should be possible to adopt similarly repeatable solutions in very many cases.*

Introduction

Since system dynamics addresses fundamental mechanisms that complicate policy-making in a wide variety of sectors, it is no surprise to find great diversity in the professional work that is reported – and work that goes unreported will likely feature still-greater diversity. Nevertheless, many domains feature very similar organisations, undertaking very similar activities and facing widely-shared challenges, for which well-established model-based solutions have been developed. In the strongest such cases, experienced

professionals have built substantial practices around such common models along with the expertise needed to deploy them. Examples of such domains and illustrative references include water and power resources (Ford, 2009), renewable resources (Moxnes, 2004), infectious diseases (Thompson and Tebbens, 2007); pharmaceuticals marketing (Paich, Peck and Valant, 2009), and project management (Lyneis, Cooper and Els, 2001).

However, although common model structures for dealing with common classes of challenge may exist, professional system dynamics work does not simply "photocopy" any given model from one case to the next, but adapts and extends it so as to capture the specifics of each situation. The standard structure dealing with the spread of infectious diseases, for example, led to the model-based policy for the eradication of poliomyelitis (Thompson and Tebbens, 2008; 2008) , but only after substantial adjustments to deal with different types of imperfect immunity, and a latent period for the disease, as well as segmentation of populations by age-group. Many of Homer and colleagues' healthcare models (Homer, 2012) likewise represent substantial developments on standard core structures. The wealth of models in project management, too, have evolved around a core structure dealing with work and re-work, so as to capture the reality of a wide variety of project management contexts, often to a considerable extent and in considerable detail (Lyneis and Ford, 2007).

This adapt-and-deploy approach has had much impact in domains where it has been deployed, although it is still reliant on considerable consulting-led effort to carry out that adaptation. That success, though, begs the question as to whether there may be a whole class of problem-issues that are still more similar between related contexts, to the extent that complete models might indeed be '"photocopied" from case to case, with nothing more than the relevant *data* being modified. Such standard solutions are common in a whole range of other fields. Examples include the documented procedure-manuals in retail franchise systems, single-purpose information-systems, corporate balanced score-cards, and entire enterprise resource-planning (ERP) systems. What such solutions commonly lack, however, is adequate handling of mechanisms that cause dynamic complexity – accumulations, interdependence, feedback and threshold effects – precisely the mechanisms that system dynamics is designed to handle.

The system dynamics literature is replete with examples of studies and models to test alternative policies for tackling diverse challenges in many domains of human activity. Many such papers deal with situations that are typical of large numbers of near-identical organisations and/or issues. A scan of the last 10 year's papers in System Dynamics Review (SDR) identifies a number of case where potentially repeatable solutions have been developed.

Rich (2008) reports on a model aimed at improving policies for controlling the spread of foot-and-mouth disease in South Africa. Control of this disease is an issue in many regions, so model might usefully have

been embedded in the policy-making of all organisations concerned with this topic throughout the world. Indeed, since this specific disease is illustrative of a whole class of problems, it might further be hoped that equivalent models are deployed in policy-making for all such issues. Dudley (2008) is one of a long stream of papers showing how system dynamics models can improve substantially the management of fisheries. Given the large cumulative body of work on this topic, it might be expected that all organisations faced with this task would now be using standardised system-dynamics-based management systems for this purpose. Bianchi and Montemaggiore (2008) report on the building of a system-dynamics-based balanced scorecard for the planning and control of a public water utility company. Such a solution should be of value to the many such companies that exist throughout the world. Carter and Moizer (2011) show how a system dynamics model can improve the front-line delivery of police emergency-response services in a single police force – another issue shared by numerous similar organisations. A special issue of SDR on transportation offers articles on solutions to several widespread challenges that arise in this domain. In the two most operationally-focused cases, Fallah-Fini, Rahmandad, Triantis and de la Garza (2010) describe how system dynamics can be used to optimise highway maintenance operations, and Bivona and Montemaggiore (2010) show how public transport providers can improve on myopic fleet maintenance policies. Both topics will be of concern to thousands of similar organisations.

In spite of the ubiquity of these challenges and the apparent success of system dynamics in these specific cases, little attention appears to have been paid to the opportunity to codify these or related solutions and embark on efforts to achieve their universal adoption by all – or at least many – of the comparable organisations who might benefit from their use. This is a serious matter for the system dynamics field as a whole, which has long faced the problem of very low awareness and appreciation among policy-makers in the many sectors where it can be a valuable tool. It appears there is a problem of adoption, or "diffusion", for which the field itself has powerful models (Milling, 1996; Maier, 1998; Repenning, 2002; Wunderlich, Größler, Zimmerman, Vennix, 2014)!

It may be that SD practitioners have been disinclined to seek such repeatable solutions, either to protect their future stream of consulting income, or to observe the common exhortation to "model the problem – not the system" (which, curiously, is somewhat in conflict with Forrester's encouragement, noted above, to model *classes* of situation, not individual cases). An alternative philosophy might indeed attempt to model "a system", at an appropriate level of detail, precisely to ensure that problems do not arise in the first place!

This paper discusses a case in which a complex challenge is shared by a large number of organisations, whose circumstances vary considerably, but who, nevertheless, are trying to deal with their own copy of the same fundamental system. Not only is it not feasible in this case to provide tailored model solutions to all these organisations, but it is not necessary to do so. Furthermore, although the issue is a substantial one-

off challenge, those organisations also require the facility to manage the situation continually in the medium- to long-term future.

Elderly-Care in England and Wales

Although the pace at which frailty increases with age varies considerably between individuals, between segments of populations and between whole countries, aging populations are putting increasing strain on social and health-care provision in all developed economies. The same strains are starting to appear in emerging economies with as-yet quite young populations.

From the point at which frailty requires support from others, various mechanisms exist to provide that support, ranging from family members, through home-based care or live-in support from professional carers, to residential care. The pathway any individual follows through these states varies, but in the UK, the principal care-modes of concern to social services divides into three main types – home-based care, in which an individual is looked after in their own home by carers who visit daily for short periods, Residential Homes, where reasonably able individuals can be attended to more immediately, and Nursing Homes for those with medical needs. This study concerns Residential Homes and Nursing Homes, collectively referred to as Care Homes.

Although some Local Authorities (LAs) have operated Care Homes and elderly-care services directly, this is increasingly rare, as policy has swung towards buying-in capacity from third parties. All such providers and the Homes they operate must be registered with the Care Quality Commission. Those providers may be small owner-operators of single Homes, or large enterprises operating many Care Homes throughout a region or the whole country. Both for-profit and non-profit organisations operate such Homes.

Historically, individuals mostly paid for their care needs from pensions and other income, or by realising any assets they owned, but LAs were obliged to pay for care from the point which individuals no longer had sufficient income or assets to cover their own costs. The level of assets at which the LA would pick up the cost was very low, at just £23,000. This situation caused public and media outrage, firstly because people had to sell their own homes to pay for care, and secondly because thrifty individuals who had saved during their working lives were penalised compared with individuals who had not. The Government therefore set up a Commission on Funding of Care and Support, whose 2011 report recommended [a] that individuals' lifetime contributions towards their care costs (previously unlimited) should be capped, [b] that no-one should be obliged to dispose of assets below a much higher value, and [c] that no-one should be

forced to sell their home to pay for care. LAs would thus be obliged to pick up the costs of more frail elderly people, earlier than would previously have been the case.

The proposals to implement the Commission's (modified) recommendations appeared in the Care Act, 2014, which *also* required LAs to assist local residents requiring care that the individuals themselves would pay for (that is, prior to those costs being paid for by the LA), and to maintain a "viable market" that would ensure adequate provision of care in their areas. All these requirements have considerable implications for LAs, both practical and financial.

System dynamics has been widely used in the public policy domain, but most such work has focused (usefully!) on ex-ante evaluation of the likely impact that optional policy changes could have on some issue of concern. The case discussed here is somewhat different, in that it concerns a major one-time shift in legislation that has already been enacted – without the benefit of prior modelling – and that will have potentially serious consequences for many public authorities. Such influential events are difficult to plan for ahead of time and the consequences are hard manage once they occur, simply because there is little previous experience to exploit. A somewhat similar case concerned the introduction of the Temporary Assistance for Needy Families (TANF) programme in the USA (Zagonel and Rohrbaugh, 2007; Zagonel, Rohrbaugh, Richardson and Andersen DF, 2004). There, too, legislative change by central government imposed obligations on local government, with little understanding of the impact that those obligations would have, or of what policies might be best suited to coping with those impacts.

Possible effects of the Care Act

At the present time, exactly how the Care Act will be implemented remains unclear, particularly as concerns the level of financial assistance that may be provided by central government to LAs through the Department of Health, and how strenuously some of the Act's provisions will be enforced on LAs. For example, just how far will LAs have to go to "assist" individuals in organising their own care? However, certain consequences are already clear, regardless of these details.

First, the requirement to help people seeking accommodation, even if they pay for it themselves, will likely bring greater transparency to the prices being paid for Care Home places. (The public discussion of the proposals has already brought attention to the issue). Having long funded the care of many impoverished individuals, LAs already purchase whole blocks of rooms in individual Homes, and set up larger block contracts with companies or non-profit organisations operating many Homes. Their buying power is therefore considerable, and this has enabled them to drive prices down to low levels, to the benefit of local tax-payers whose taxes pay for these services. Price, here, is the fee-rate paid per resident-week – the "LA fee-rate" for short. Home operators tolerate this pressure and low fee-rates because the blocks of places

taken provide a base level of guaranteed income, rather in the way that airlines fill most of their seats with early-booking passengers at low fares.

A small fraction of Care Home places, needed by people with more than minor medical needs, are paid for by the National Health Service (NHS), whose fee-rates tend to reflect LA fee-rates, but with a premium to pay for the medical care required.

People paying for their own care, known as self-funders (SFs), have had no such negotiating power, so have had to "take it or leave it" for the prices they are asked to pay – the "SF fee-rate", for short. As a result, a gap has opened up between LA fee-rates and SF fee-rates, which is effectively a cross-subsidy from self-funded to LA-funded residents. This cross-subsidy is most substantial in more wealthy regions. In poorer regions, where self-funded residents cannot pay high fees, they end up being paid for by the LA in any case, leading to a situation where *both* the SF fee-rate premium is limited *and* Homes receive a large fraction of low-paying LA-funded residents.

The first risk for LAs (indeed, not so much a risk but a certainty) is that on the date the Care Act commences, they will immediately become responsible for the care costs of many current SFs whose asset values like between the current low level and the new, higher level. The second risk is that SFs will set up "personal care accounts" (PCAs) to track the cumulative amount of their own money spent on care, so that when they reach the life-time contribution limit they can demand that their LA picks up the cost. The extent of this risk is less certain, since it is not known how many possibly-qualifying individuals will in fact set up PCAs. However, those who do so will progressively reach that cap over future years, imposing on LAs a second and an increasingly large wave of costly obligations to pay for their care. Thirdly, as LAs implement their new responsibilities, the cross-subsidies between LA fee-rates and SF fee-rates will become well-known. Care Home residents, their families, financial advisors and pressure groups will therefore demand lower fee rates, closer to the levels paid by the LA. This has knock-on implications for the LAs' second obligation – to ensure adequate provision – at two levels.

1. Average revenue to Care Homes from fees paid by or for their residents should be high enough to ensure that few Homes close. Home operators typically strive to keep operating, even when fees barely cover direct operating costs, motivated both by concern for their residents, and by hope that things will get better. However, if fee income falls below cash operating costs for any length of time, either the operator or their bank or other lender will be forced to close the Home.
2. Secondly, since it takes at least 2 years to plan and build additional rooms at existing Homes, and 3 or more years to plan and build new Homes, the *likely* profitability that operators might hope for

from making the required investment must provide enough return on the capital cost of doing so to justify the risk.

There is thus a pair of thresholds for average fee-rates and Home profitability – a "floor" below which Homes are likely to close, and a "ceiling" above which new Homes and rooms may be built. Homes differ widely in size, and thus in efficiency and profitability, so both affect small and large Homes differently. At any given average fee-rate and occupancy level, small Homes are more vulnerable to closure than are large Homes, and new large Homes are more likely to be built than are new small Homes. Smaller homes may, though, be viable if, for example, they target self-funded residents who pay higher fees, or are paid LA fee-rates somewhat above the lowest rates the LA could command for places in larger Homes.

The substantial risk of the Care Act for overall provision of elderly care is, first, that it will substantially increase the cost to LAs for that provision, and secondly, that it will raise transparency on fee rates, causing self-funders to demand lower prices, *average* fee-rates and Homes' profitability to fall, and both the closure of many Homes and the halting of additional capacity needed. LAs can therefore no longer ignore the self-funded segment of the market, as they have largely done in the past, but must develop the intelligence and the means to manage the market as a whole.

Uncertainties and Local Authority responses

There are considerable uncertainties in this situation. First, it is not known how transparent pricing levels will actually become, or by how much this transparency could reduce SF fee-rates that Homes can charge. The resulting fall in SF fee-rates could also lead to an increase in demand – if prices fall, then frail elderly people who currently struggle on in their own homes could find Residential Home places affordable. LAs could then face both reduced availability of places for the people they pay for *and* less willingness by providers to accept LAs' lower fee-rates.

There are also uncertainties on the supply-side of the market. Low prices force Home operators to cut costs, by cutting staff numbers and limiting pay rates. If low fee-rates force both low pay-rates *and* work over-load due to under-staffing (already a widespread problem), operators may be unable to find enough staff to operate their Homes and be reluctant to build more. The uncertainties caused by the Care Act could also cause operators to hold back on expansion plans until it becomes clearer how the market will develop.

Home operators, especially the larger groups, are already adapting. LA fee-rates in some regions are so low that operators are refusing to accept the people that LAs need to place. More worrying still is that some operators cannot justify building new Homes for the low revenues reflecting LA fee-rates, so are building higher-specification Homes only to serve self-funders. This risks creating a two-tier market, in which the more valuable self-funded segment is skimmed off to provide good profits to some operators, leaving low-

specification Homes to struggle with an increasing fraction of low-fee LA-funded residents. This, in turn, poses serious quality risks. With operating costs largely dominated by staff labour and, to a lesser extent, food, a Care Home struggling with low fee-rates has few options but to cut back on staffing and food quality. While the CQC undertakes quality-checks and can close Homes where care-quality standards are inadequate, care standards can nevertheless be low enough for the experience of residents to be fairly miserable long before that point is reached.

Finally, there are substantial inter-locality issues. Home operators already build new capacity preferentially in more affluent regions, risking under-provision elsewhere. Conversely, some large groups continue to operate low-profit or loss-making Homes in poorer regions, effectively subsidising those Homes from more profitable units in richer regions. There are also significant cross-flows of residents between LA areas. Most commonly, newly-frail elderly in urban boroughs frequently seek care in suburban areas or rural counties. There are already substantial differences between neighbouring pairs of LAs in both SF fee-rates and LA fee-rates, and changes to those differentials will likely disrupt those cross-border movements, especially if pricing transparency causes different changes to occur in each area.

LAs have various options to respond to these uncertainties. First, they could raise the fee-rates they pay, in order both to reduce the apparent cross-subsidy paid by self-funders and also to protect the financial viability of existing Homes and ensure that new Homes will be built. Unfortunately, this is very costly. One LA, for example, already spends some £100m/year on places in Homes, and the differential between SF fee-rates and LA fee-rates is currently so wide that even meeting fee-rates in the middle (so SF rates fall and LA rates rise by the same proportion) would raise costs by £30m/year. The question, then, is "*By how much do LA fee-rates have to rise to reduce the downward pressure on SF fee-rates enough, so that the new weighted average fee-rate is sufficient to keep existing Homes open and ensure new Homes are built*?"

A further range of options open to LAs involve changing their policy towards the kinds of elderly care they encourage and fund. The key item in this set concerns the encouragement of home-based case, which many elderly people in any case prefer, to defer the time at which they have to move into Residential Homes. More sophisticated versions of this policy involve encouraging developers to build significant quantities of housing which people can buy or rent, but which are clustered around care-provision service centres.

Different LAs are currently (March, 2015) in *very* different starting positions when trying to answer the question above. Just a few already pay enough that, with the higher SF fee-rates, no Homes are in danger of closing and plenty of new Homes are being developed. Still, a partial equalisation of fee-rates is likely even in these cases, and raise LA costs. In the worst cases, LA fee-rates are well below the levels needed to ensure Homes stay open, and certainly too low to justify the investment in additional capacity. What is

worse, those regions also feature lower proportions of self-funders, and those self-funders that exist cannot pay the high SF fee-rates of richer regions, so Homes are more dependent on LA fee-rates.

How supply and demand for Care Homes adjust

LAs have been so concerned about the practical and financial challenges the Care Act could cause that a group of 12 County Councils (out of a total of some 150 affected LAs) asked consultants LaingBuisson (LB) to research, collate and analyse extensive data from diverse sources on Care Home demand, Homes and places, fees, revenue, operating costs and investment. This study was felt to be critical, not only for the LAs to undertake their own planning, but also to facilitate discussions with central Government, who are imposing these new obligations on LAs with little understanding of the implications while resisting calls from LAs to pay for the additional costs. Recognising that the inter-play between these elements is dynamically complex, LB requested development of a model that could replicate recent behaviour of the market in each LA's area since 2005, and project likely future behaviour under a range of scenarios and policy options out to 2025. The long time-scales are required because of the very long lead-times involved, and because LAs set up agreements with providers for many years.

The scale of this task is substantial, since it requires capturing or estimating data since 2005 for every LA area, on:

- capacity, and changes to that capacity, for every registered Care Home, divided into eight distinct categories: Residential-v-Nursing Homes, small-v-large Homes, and those operated for profit and not-for-profit
- numbers of frail elderly people and their care needs
- average LA fee-rates and SF-fee rates
- typical fixed and variable operating costs for each of the eight categories of Home
- build-costs for adding rooms to existing Homes and building new Homes

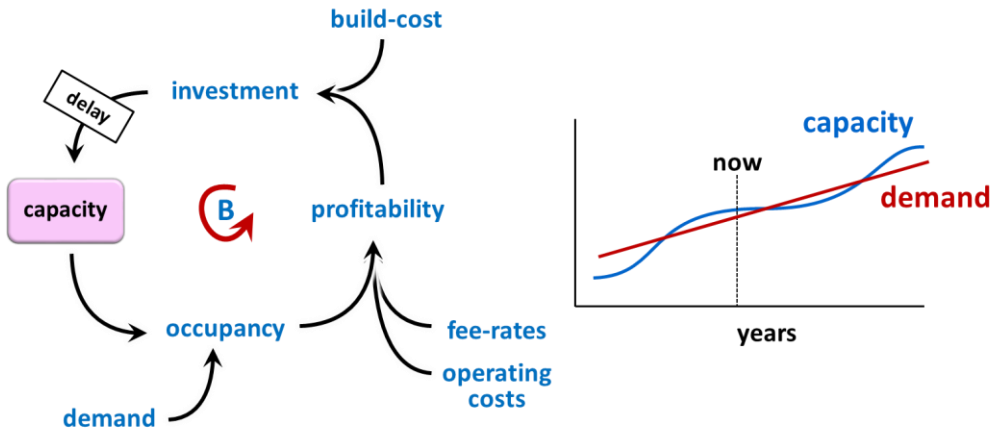
Producing modified models tailored for every LA was clearly impractical, even for the first 12 LAs in the consortium, let alone for all 150, and is in any case unnecessary. The essential elements of supply and demand are the same in every case, as are the relevant mechanisms by which supply and demand adjust. The only elements that vary between cases are the values of each element, the behaviours of key players (notably the elderly people or their representatives and the Home operators) and the policies of each LA. Diverse models for each LA would also have led to a sub-optimal solution, obstructing useful comparisons and learning, as well as being unaffordable, unusable by professional LA staff, and impossible to maintain.

Certain elements of the model are relatively "linear", with changes causing direct and quantifiable outcomes – for example, the numbers of people with assets between the old, lower level and the new, higher level

who will switch from self-funding to LA when the Care Act comes into force. However, other elements are less straight-forward, notably the capacity adjustment that could occur with closure and opening of Homes.

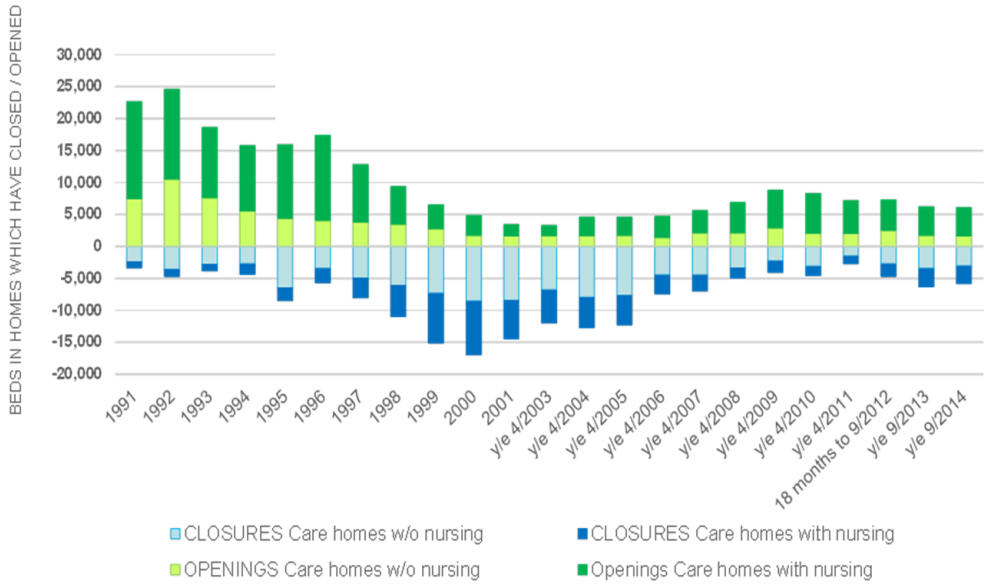
The essential structure of the required model features a well-known system dynamics structure – capacity-adjustment with delay, responding to steadily rising demand (figure 1). The balancing feedback in this structure would, in the absence of delays, ensure that capacity constantly changes to match demand, but the delays in planning and construction cause capacity to lag behind demand for some period (Sterman, 2000, chapter 20). During that time, the incentive to build intensifies, causing more new capacity to be initiated. In efficient commercial markets, prices for the relevant commodity increase, causing profitability to escalate sharply, especially when there are substantial fixed costs for operating capacity. This promises good returns on investment (ROI) for any supplier who takes the risk to build new capacity. Since this incentive applies to *all* suppliers, many may invest, so that when new capacity eventually opens, it can raise total capacity above demand, especially if capacity comes in large units. This reduces utilisation, hitting profitability (again, especially when fixed costs are substantial) and killing the incentive to invest further. So no new capacity is added until the next time that shortages emerge, and the cycle starts again. If profitability is especially poor during periods of excess capacity, it may cause business failure and/or the closure of loss-making capacity.

Figure 1: Capacity adjustment and delay in Care Home provision



These relationships apply directly to the market for Care Homes, and have caused exactly the cycling of capacity additions and closures that might be expected (figure 2). There is steadily rising demand, many suppliers, new capacity comes in large units – typically 50-100 rooms for a new Home. Fixed operating costs are high, so profitability is very sensitive to pricing and utilisation (occupancy), and if smaller or less-efficient Homes become unprofitable, they close.

Figure 2: Historic additions to, and losses of Care Home places,



There are, however, important features specific to this industry. First, for self-funded residents, a Care Home place is often a "distress purchase" so they must have a place *somewhere*, and cannot then easily leave a Home if they feel the price is too high. Relatives may also be reluctant to push for lower prices, for fear that their elderly relative may not get the attention they would wish. Secondly, unlike many commercial commodities, price-levels are not at all transparent, so SF fee-rates may remain high, even if there is widespread over-capacity. This means that there may be a strong case for building new Homes at the same time as many existing Homes are closing, as figure 2 clearly shows. This is reinforced by the market's segmentation – there is a *very* wide divergence between the fees that more or less wealthy consumers are willing and able to pay and what poorer residents or the LAs can afford. This is mirrored in differentiated provision of Homes, and rooms within Homes, and in service levels.

The great purchasing power of LAs, plus their responsible wish to keep down local taxes, drives them to keep fee-rates low for the large-scale, long-term contracts they offer to Home operators. Only when they find difficulty placing residents in Care Homes, are they forced to pay more, which raises Homes' profitability. Even then, the overall impact on average LA fee-rates may be small. Although an LA may only be able to find a place for a new resident if they pay 20% or more above their usual contractual fee-rates, the large stock of previously-agreed contracts will continue to dominate their average fee levels.

As in other industries, capacity will only be added in response to shortages if profitability rises sufficiently to motivate new investment, given the cost of building. In commercial markets, that profitability may be raised by high utilisation *and* by quickly-rising prices. In this case, the inability of residents to respond to

price changes together with LAs need for long-term contracts should act to slow down such changes in price. Nevertheless, prices *do* adjust somewhat, causing Homes' profitability to rise or fall substantially, if not as dramatically as can be seen in other industries.

Modelling demand and supply adjustments

The essential outline of the system from figure 1 is translated into the core model structure shown in figure 3. The *whole* structure is replicated for Residential and Nursing Homes and all of the structure except the demand elements at lower left is further segmented between small and large Homes and between by for-profit and non-profit providers.

1. Demand is calculated at lower left from the numbers of elderly people in each age-cohort and the fraction of each cohort requiring each type of care. This "latent demand" may not be fulfilled if there are insufficient places.
2. This latent demand for Nursing or Residential places is then compared with the total number of places of each type available (summed across large and small Homes with all providers) to estimate the potential and actual occupancy – the percentage of places occupied. Actual occupancy is limited by practical considerations to 90%, but potential occupancy may exceed this value if latent demand exceeds 90% of available places.
3. The revenue received by Homes in any category is then worked out from the average number of occupied places per Home (rooms multiplied by occupancy), the proportion of those places paid for by self-funders, the LA and NHS, and the fee-rate paid by each group – plus any top-up fees paid by LA-funded residents for better facilities.
4. Normal operating costs are calculated for each size and type of Home, and deducted from revenue to calculate cash operating profits.
5. A separate level of profitability [not shown separately] determines Home closures. The Homes most likely to close are those most dependent on low LA fee-rates, and those Homes will try to cut their costs to survive. There is a lower limit to these costs, however, known as their "stressed costs". Closure will be unavoidable if revenue, dominated by low LA fee-rates, is less than these stressed costs, because the Home is then running a cash loss, which cannot continue for any lengthy period.
6. The current profitability is used to work out the *potential* profit to be made by opening a new Home or to add rooms to existing Homes, and that potential profit is compared with the required capital costs to work out the likely ROI.
7. If more places are needed, and the potential ROI is adequate, then new Homes and additional rooms are built, and become available after the relevant planning and construction delay.

Figure 3: Structure of the core model

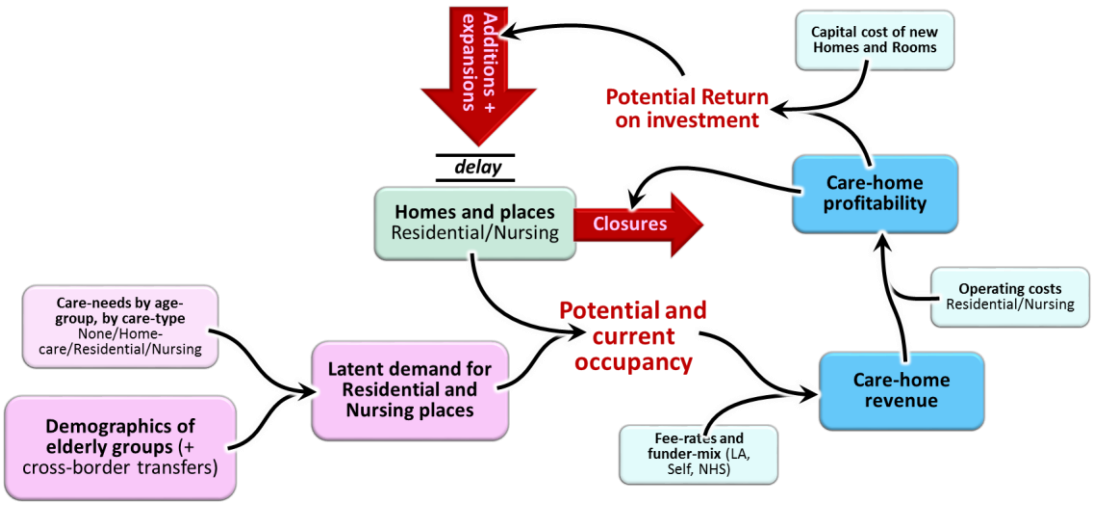
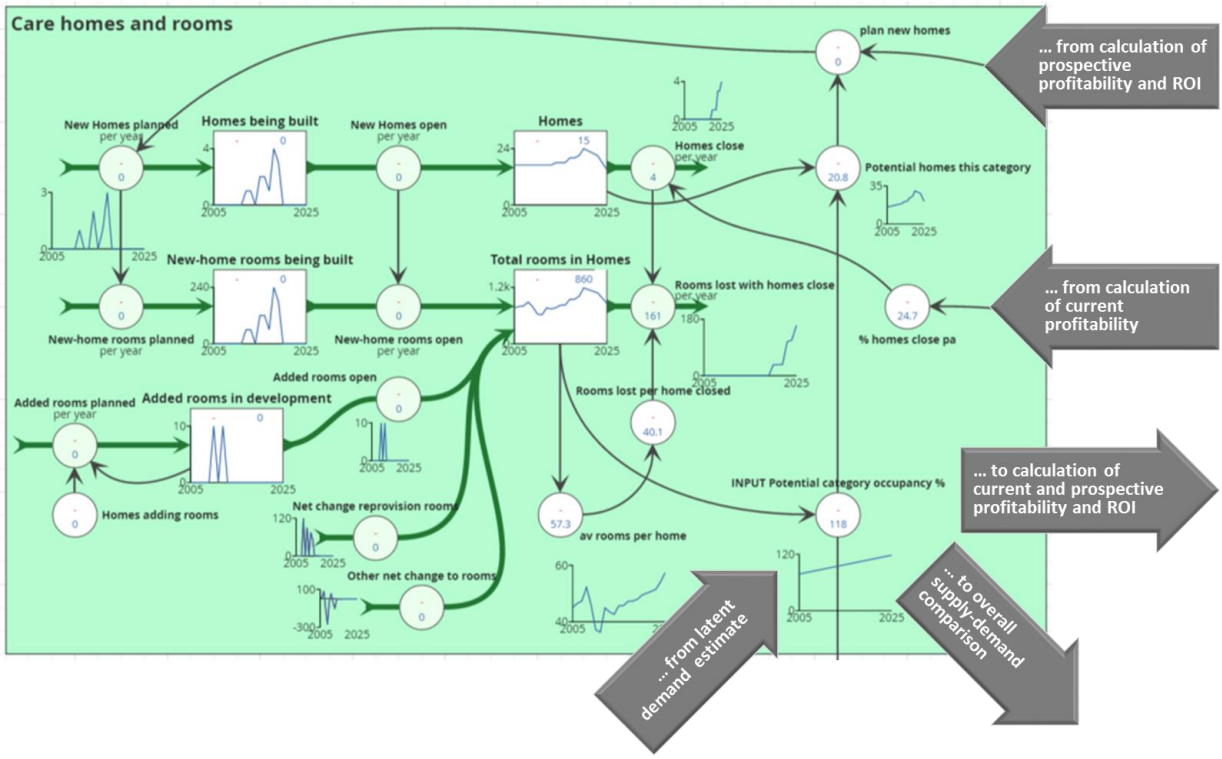


Figure 4 shows the section of the model dealing with the rate at which new Homes and additional rooms are added, and existing Homes are closed. This model depicts changes between 2005 and 2025 for a particular category of Homes for a certain County, and can be inspected for each of the eight separate categories of Home. It is in fact a sub-model, fed with information on latent demand from an overall Market model, and returning to that Market model the updated data on Homes and rooms available. The sub-model also includes segments (to the right of figure 5) to calculate profitability and ROI and (below figure 5) to work out the fraction of Homes most exposed to low LA fee-rates and thus likely to close.

Figure 4: Calculating the addition and closure of Homes and rooms in any category



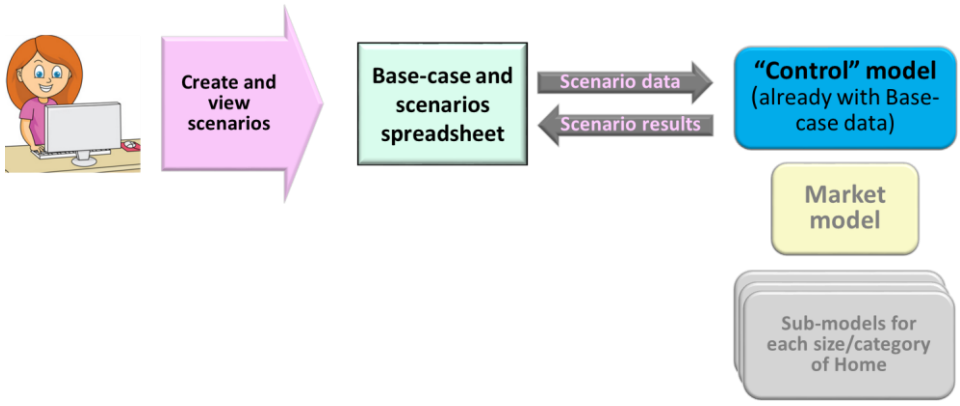
The Market model handles the County-specific data that drives the demand on each category of Homes and the aggregated consequences for the supply-demand balance. It calls back from the sub-models under its control information on the profitability of each Home-category, and cost of LA fee-rates for LA-funded residents in order to assess the overall cost impact for the relevant LA.

The model was used repeatedly with representatives of two extreme cases – a prosperous County and one of the least prosperous – to ensure the model reflected changes that had occurred to the availability of places, the financial performance of Homes (anonymised information on which was supplied by Home operators) and the likely prospects for these factors over the next 2-3 years. Much is already known about this period, such as capacity in development and likely changes to costs and average fee-rates, which are either contracted by the LA or subject to limited changes for current self-funded residents.

Although the Market model is reasonably intuitive to use, the data required comes from spread-sheet sources with which the consultants and LA analysts are familiar. This Market model is somewhat extensive, and includes many variables that are neither parameter inputs nor results of interest. These models also need to be driven by LA-specific data, and deliver LA-specific results, so the Market model is therefore run by a Control model which handles only this essential sub-set of data.

Since copying this data manually would be tedious and prone to error, a summary data spreadsheet for each LA was equipped with an add-in that sends input data to the Control model, that then drives the Market model and sub-models, and pulls out the required results (figure 5). The spreadsheet is equipped not only with base-case data values, but also with modified values for the 2015-2025 period split into a number of Scenarios, requested by the LAs. LA analysts run the model, testing Scenarios and policy options, simply by changing assumptions and parameters in the spreadsheet and triggering the dynamic models to be refreshed.

Figure 4: The user interface relationship with the dynamic models

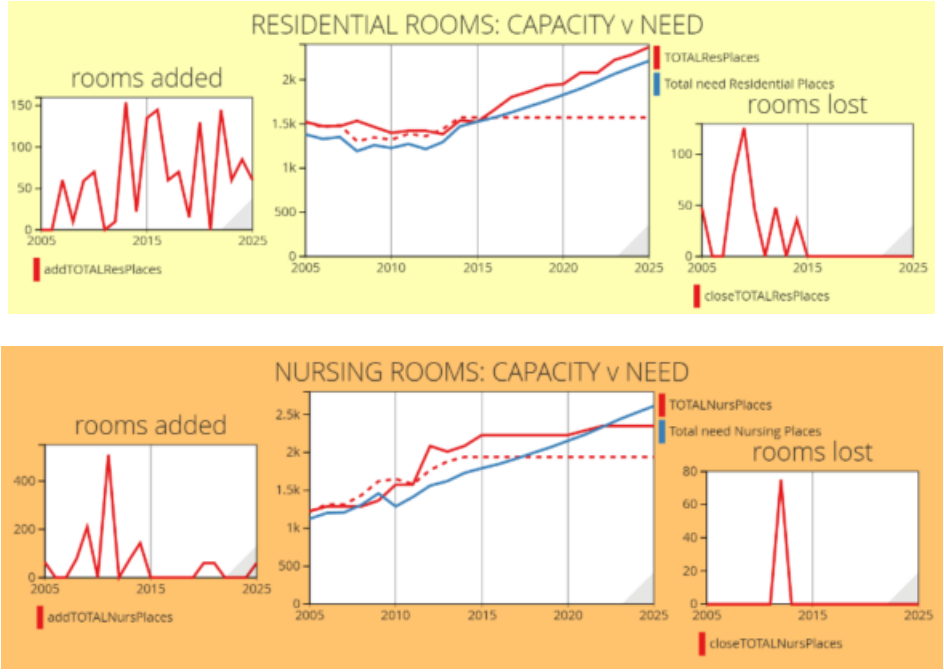


Validating the models

The explicit presentation of live time-charts for every changing parameter in every part of this sub-model and in the Market and Control models, including historic actual data where appropriate, enables real-time adjustment and checking of parameters and relationships. The closure of Homes and loss of rooms shown above in the later years of figure 4, for example, corresponds to a probable fall in Homes' revenue in a scenario where self-funded residents are increasingly resistant to paying higher fee-rates than the LA. Note that the loss of rooms around 2010 arises from idiosyncratic events occurring to this particular category of Homes, in the relevant LA region.

Figure 6 shows an example from the Market model of one County's historic need and availability for Residential and Nursing Home places, and the related additions and closures. Dashed lines show the known actual numbers of places up to 2014 (the constant value thereafter is irrelevant). The perhaps surprising gradual fall in latent need for Residential Home places to 2012 reflects a corresponding increase in alternative provision of at-home care over the same period, which reduces the flow of new residents requiring Residential places.

Figure 6: Example of supply-demand scenarios for Homes needed and available in a prosperous County



The fit between historic actual values and model values in figure 6 is not especially good, since the historic data includes certain known anomalies, such as the sharp drop in demand for Nursing rooms in 2010. Since the model estimated that Home profitability prior to this point was strong, it initiated a large investment in new Homes and rooms which were predicted to come on-stream by 2012. In reality, somewhat less additional capacity was added. All LAs' historic information featured similar anomalies, each of which was scrutinised and explained, to confirm confidence in those dynamics that the model was able to capture.

With information on 12 separate LAs, whose circumstances, policies and information varied considerably, confidence in the model was sufficient to allow valuable exploration of alternative scenarios, and testing of policy responses. Figure 6, for example, shows that current supply of Residential places is barely adequate, but profitability for Home operators in this prosperous County is sufficiently high that new Homes are being built and will likely continue to be built. For Nursing Homes, on the other hand, there is some surplus capacity (rather less than the model is suggesting), but current and likely fee-rates for Nursing care are not sufficient to encourage investment in the additional places that will be required. Given the anomalous current surplus of places, some shortage is therefore likely by 2018, rather than 2020, as the model implies. However, historic, current and likely future profitability for both Residential and Nursing Homes is certainly high enough that closures due to financial distress are most unlikely. (The historic loss of Residential places is due to a re-designation of Homes from Residential to Nursing registration, which resolved both the reduced demand for Residential care and the rising demand for Nursing places).

Scenario and policy-testing

Using each County's detailed, locally-specific spreadsheet data to drive the model allowed a wide variety of scenarios to be tested, and policy-responses to be assessed. The principal scenarios originally specified by the sponsoring Counties is as follows:

A. Falling self-fund premium

1. Self-fund premium v. LA fee rates halves over 5 years
2. … as A.1, but LA fee rates also rise to close the gap totally over 5 years
3. Self-fund premium v. LA fee rates fall to LA fee levels over 5 years

B. Quality concerns reduce capacity (temporary closures)

4. Reduce occupancy limit from 90% to 85% over 5 year

C. Divert people to Home Care

5. Divert people from Residential Homes [only – not Nursing] to Home-based Care … and A.1 Self funders close half the fee premium over LA fee-rates

D. Lower increase in fee rates

6. LA fee rates grow 1%/year, not 2%
7. … as D.6, but SF fee rates also grow only 1%, not 3%

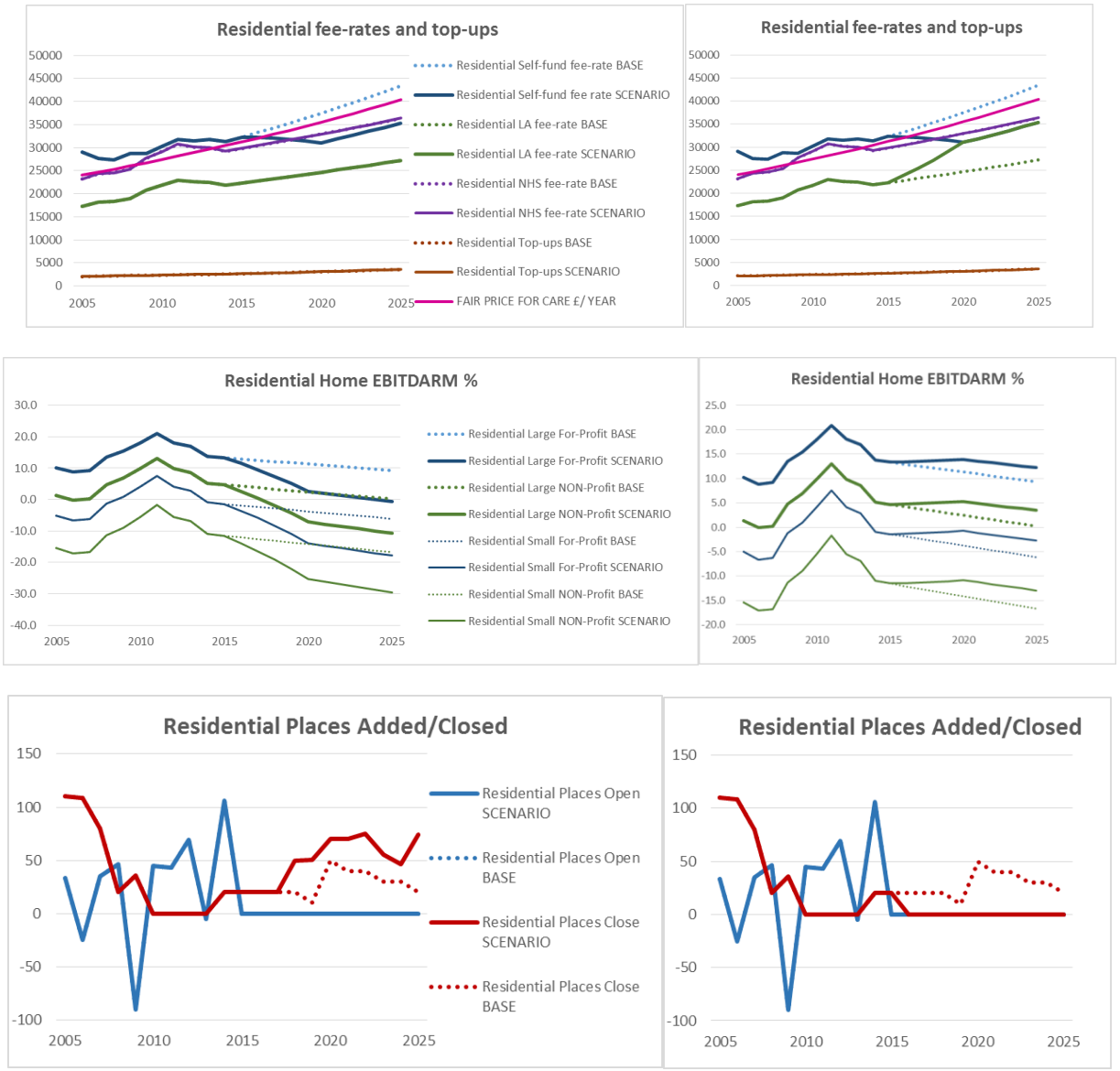
Some other outcomes are in fact certain, rather than merely likely. For example, when the Care Act comes into force, those residents whose assets fall below the new, higher asset-value cap will *immediately* switch from self-funding to LA-funded, imposing a one-time increase on each LA's costs that will have to be paid for either by an increase in local taxes or compensation from central Government.

Some of the numbered Scenarios above deal with likely consequences arising from the Care Act, such as changes to the fee-rates that self-funded residents are willing to pay (A1), whereas others reflect policy responses available to the LA to handle those consequences. Scenario A1, for example, is a "consequences" Scenario that will likely reduce Care Home profitability – very substantially in some LAs, but less so in others – resulting in possible Home closures and failure to provide required increases in capacity. Scenario A2, therefore, is a "policy" Scenario that assesses the degree to which compensating increases in fee-rates paid by the LA might mitigate the reduced profitability and sustain the required growth in capacity.

The circumstances and prospects emerging from the model differ between Counties to a surprisingly large degree. In the less prosperous LA used for detailed testing, for example, more residents are funded by the LA than pay from their own resources. Not only are absolute levels of fees paid by both self-funded and LA-funded residents much lower than in the prosperous County, this greater reliance on low LA fee-rates

further reduces the weighted-average fee-rate paid to Homes. This situation has worsened since 2012, as budget pressures have forced the County to reduce the fees it pays (upper-left chart in figure 7).

Figure 7: Estimating the impact of fee-rate scenarios on profitability and Home closures in a less prosperous County



Since a relatively small reduction in fee-rates translates into a substantial fall in profit margins, profitability[1] of Homes in the region has moved from barely adequate in 2011 to badly inadequate in 2015, risking the closure of many smaller Homes in the next 2-3 years. Fortunately, being small Homes, the corresponding

[1] EBITDARM is a measure of cash operating profit – earnings before interest, tax, depreciation, rent and management costs – and the EBITDARM margin is the percentage of revenue that this profit represents.

loss of *rooms* is less severe than if larger Homes were to close. Nevertheless, these closures will cause real hardship for both the operators and for their residents. The data on profitability and closures for the 2005-2009 period gives confidence that the estimated closures for the next few years are a realistic expectation. The data on rooms *added* during 2005-2010 includes some unexplained net changes in the raw data (hence the negative 'additions' in certain years), but also shows some real additions during 2011 and 2013, following a brief period of higher fee-rates and better profitability.

The left-hand column of charts in figure 7 compares scenario A1 with the base case for this poorer County from 2015-2025, while the right-hand column compares scenario A2 with that same base case. In the base case (dotted lines) both self-funded and LA fee-rates rise slightly slower than the inflation likely for Care Home operating costs. This results in the EBITDARM profit margin for larger Homes (thicker lines) falling gradually from about 5-15% (for non-profit and for-profit homes respectively) to 0-10%.

Still in the base case (dotted lines), 2015 profitability for smaller Homes (thin lines) is already at or below zero, and falls further. This results in the continued closure of small Homes, with the loss of some 2-300 places over the next decade. There are no additional Homes or places provided, because profitability, even for large, efficient Homes, remains far below levels that would justify any investment.

In scenario A1 (left-hand charts), where self-funders increasingly resist paying more than the LA, SF fee-rates fall half-way towards LA fee-rates over 5 years. This gradual reduction occurs because of the slow replacement of the current stock of residents with a new intake unwilling to pay the premium tolerated by their predecessors, and also because of increasing visibility of the discrepancy. Scenario A1 causes an approximately 10% worsening of already-poor profit margins, and escalating rates of Home closures, with the loss of some 5-600 places over the next decade. Closures would be still more numerous if Homes did not push down their costs to "stressed" levels, keeping their profitability just above zero, but causing very poor service to their residents.

The base case is already intolerable to the LA, since it fails to provide any of the additional Residential Home capacity required to serve increasing numbers of elderly people with that need. Scenario A1 is still more intolerable, clearly failing the LA's mandatory duty to maintain a viable market for elderly care. Scenario A2 (right-hand charts) therefore tests the impact of the LA *raising* its fee rates over the same 5-year period to meet the now-lower self-funder fees. Both groups end up paying significantly less than the fair price for care. However, since most of the residents in this County are paid for by the LA, the net effect is to raise *average* fee-rates and support current profitability rates for most of the future period. This is enough to prevent Home closures entirely, though not enough to encourage new Homes to be built (not shown, as this is zero in every case). Worryingly for the LA, the cost of even this partial solution already represents an increase in its total elderly-care costs of some 30%. This is, however, the worst case among

the 12 Counties, a few of which (such as that depicted in figure 6) are within reach of a sustainable future provision at little additional cost.

Having seen these and other outputs from the model's assessment of the initial list of Scenarios above, the sponsoring LAs requested further scenarios for:

- reductions in the need-levels of different age-groups (today's 65-74 year olds, for example, are significantly more healthy than those of 10 years ago – although this favourable trend is countered by the rising *numbers* in each cohort already in the base data),
- changes to the proportion of LA-funded residents who pay top-up fees and the average amounts of those fees (the Care Act frees residents from restrictions on such payments, and Homes will likely seek such increases from residents to help make up for the otherwise-lower fee-rates), and
- the risk of a one-time increase in demand for places, driven by efforts of the NHS to free up hospital places by moving recuperating patients into Care Homes.

Most of the scenarios discussed to this point represent a single sensitivity, or at most a combination of two. However, it is more useful to consider composite Scenarios that combine several of the changes most likely to be caused by the Care Act, and several of the potential policy responses.

To handle this range of factors on which uncertainty arises, the series of LA-specific spreadsheets were equipped with a series of sensitivity switches, allowing any combination of possible consequences of the Care Act to be triggered, to any degree. The sponsoring LAs then agreed a common, most-likely scenario-set for these switches, to allow a common basis for assessing the likely impact on specific LAs. This mostly-likely overall scenario then formed the basis for testing a set of possible policy responses, again through a series of switches. When the relevant parameters and switches were set, each LA's spreadsheet then ran the linked model to generate results for [a] the no-Care-Act base case, [b] the most-likely Care Act impact, and [c] the policy responses to this impact. This generated comparisons similar to those shown in figure 7, but now based on a richer set of assumptions.

Necessary simplifications (at this stage)

It was inevitable that not all the data required in an ideal world would be available, so certain simplifications had to be made to the model's structure. The principal example concerns the flows of elderly people between age-groups, and the corresponding changes to their levels of care-need. Many 65-74 year-olds are frail enough to need care, for example, while many people over 85 years old are fit enough to need no care. Ideally, this would have been modelled with an aging-chain of age-groups and a parallel chain of need attributes.

Unfortunately, while data on flows between age-groups is good, even at the level of individual LA areas, the flows between need-states – the so-called "care path-ways" – is largely unknown. Consequently, a necessary simplification involved taking as given the changing numbers in each age-group and "looking up" the corresponding numbers needing each type of care from data on the typical mix of needs in each age-group.

A simplification was also made to cope with the size distribution of Homes. The actual number of rooms in every Home is in fact known, enabling clustering into any number of size-groups required – 5-9 rooms, 10-14 rooms, 15-19 rooms and so on, for example – or even agent-based modelling of this information. However, the need to make results understandable to diverse audiences made this undesirable. Fortunately, the cost and profit models of Homes feature a reasonably reliable distinction between "small" and "large" Homes, the break-point occurring at 20 rooms for Residential Homes and 30 rooms for Nursing Homes.

Repeatable, extensible solutions for planning and continuous management

Given the urgency and scale of the issue for all LAs in the country, it is hoped that the solution described thus far can be rapidly replicated, first for the remaining 25 Counties then for the other types of LA. By far the largest burden in this roll-out lies with the consultants, who will need to assemble LA-specific data for every case. Although much of that data already exists, other items will need to be sourced from Care Home providers and from the LAs themselves.

The model itself requires no further development for that deployment, and the spreadsheet add-in that drives the model is easily distributed to every LA that now requests the service. The only model-related effort that will be required at this stage is therefore the minimal task of instructing each LA on how to use the spreadsheet and model-link. The solution thus fulfils the objective described at the start of this paper – to go beyond models that, while sharing a common structure, nevertheless need to be adapted significantly to each new case, and move on to a standard solution that can be replicated with no modification.

The model described here may also be built on to achieve a second aim – going beyond being a tool for addressing a one-time challenge to become an embedded tool for continuous *management* of the relevant situation. As can be seen even from the limited historic information in the figures in this paper, the funding and provision of Care Home capacity for the frail elderly is a long-standing challenge that has previously proved hard for LAs to manage. Setting aside the disruptions that the Care Act will cause, the fundamental elements and structure of the system have remained unchanged for many decades, and will continue in the same form indefinitely.

It is also clear that the difficulties in which many LAs now find themselves might have been mitigated by different historic policies. Notably, the too-low fee-rates of the early 2000s caused closures and shortages

that were responded to by rapid increases in fee-rates that have proved unsustainable. This has left the market with the current risk that shortages will recur, fixing which will require a further swing back to higher fee-rates (regardless of the additional burden required by the Care Act). Had the LAs been equipped throughout this period with the model that has now been developed, then better policies could have been designed *and* continually modified in response to changing circumstances. Such a model would thus have been a true management system, rather than a one-time analysis tool for dealing with a single event.

The existing model is readily modified to be suitable for that purpose. Most of the data required is continually updated for other purposes – demographic projections are of course constantly updated, the CQC continually reports on every Care Home in the country, and on every addition to, and closure of Homes and rooms, and LAs constantly track the numbers of residents they support and the fee-rates they pay. The only significant additional information required concerns numbers and fee-rates paid by self-funders, but this project has shown that Home operators have a strong interest in sharing that information, albeit in anonymised form. Feeding that information into the same model, through the same interface, on a continual basis is trivially simple.

Turning the current one-time model into a continuous management tool can and should go further. The most important addition concerns data on the number of additional Care Homes and rooms that are in planning and development, since this gives confident mid-term projections of availability. Currently, those quantities had to be estimated from typical lead-times, but it turns out that the LAs themselves *have* the data to add this element to the model properly, since each runs the real-estate Planning system in their own area. They can therefore know exactly how much capacity is in the planning and construction stages, and the likely date that it will come on-stream. This and other features of the model will become more functional still if the model can receive and process quarterly data, rather than the merely annual information currently available for most items.

Finally, the model can and should be extended to cover all elderly-care activity and costs for any LA. At present, this cannot be done because the sponsoring Counties requested that project focus on Care Home provision. The whole sector of at-home care is thus excluded. Only by extending the model – and the related data-sources and spreadsheet – to include at-home care is it possible to model the dynamics of personal care accounts and the resulting impact and timing on LAs' costs.

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