

The Tangle of Growth: A Dynamic Analysis

**Growth, Sprawl, Transportation,
Housing, Farm Policy and Wages**

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Preface

I know, I know. This paper is too long for anyone to ever read and the diagrams are too complicated. I didn't mean to write a book. Really ... I didn't. In defense of the length and complication, there are lots of issues involved, it's a complex subject; and the diagrams tell the stories of what's happening in a way that's appropriate and efficient ... once you become familiar with the language and how to read them. So please bear with it.

Developing this material has been challenging, to say the least ... challenging in many ways. As noted, one challenge is that the issues are complicated; in fact, I began writing this paper simply as a way to identify and reflect on the many issues that are raised in discussions of growth and sprawl. I couldn't keep them straight in my head. The second challenge has been that, in looking at the issues, I have had to question many of the things I've believed. Some of the points of view expressed in this paper are counterintuitive and outside the current paradigm. I rejected some of them myself at first. I found I was surprised, even shocked, by many of the things I came to understand while working on this paper, and so I will not be surprised if others reject some of the assertions made here.

And finally, because some of the understandings to which I came are not considered "okay" to talk about, I found myself wanting to reject them as too politically sensitive. In the end it got so complicated to figure out what was okay to say and what was not, that I said, "The heck with it." So what you have here is unexpurgated, not the "politically correct" version.

One of the things I've come to understand in studying systems thinking is that belief, or ideology, tends to trump reason and data most of the time. Beliefs are so powerful that, for example, we continue to think we can solve the traffic congestion problem by building roads, even though we can look at other, larger cities and see that has never worked. Or we think we can continue current policy and halt the destruction of family farms, even as we continue to see them fail.

The late Donella Meadows wrote of her difficulty in getting system dynamics concepts across to the public in her columns. The paper in the *System Dynamics Review* is based on her invited address to the 1988 System Dynamics Conference.¹ She noted about one of her columns:

That column, written shortly after the 1987 stock market crash, was one of the most unpopular I ever produced. Many papers did not print it. I learned a lesson from that – you can't challenge the prevailing paradigm too directly.

But you can challenge it indirectly, bit by bit, again and again, presenting more and more evidence. Thomas Kuhn, who wrote the seminal book about paradigms that has inspired many system dynamicists,² says that what ultimately causes a paradigm to change is the accumulation of anomalies – observations that do not fit into and cannot be explained by the prevailing paradigm. The anomalies have to be presented over and over, because there is a social determination not to see them.

Challenging a paradigm is not part-time work. It is not sufficient to make your point once and then blame the world for not getting it. The world has a vested interest in not getting it; the point has to be made patiently and repeatedly, day after day after day.

Her words make it clear that there's a lot more to be done than making points in a paper such as this, which has been seen as more appropriate for an academic than for a popular audience.

As I worked on this paper, I began to see some of the relationships between a few of the issues ... to identify several basic systems thinking structures (archetypes) that affect the behavior of parts of the system. To my surprise, I believe I've been able to weave them together, at least tentatively, into an overall framework that explains the major dynamics of growth.

"Insanity: Doing the same thing over and over again and expecting different results."

Albert Einstein (1879 - 1955)

Insanity in individuals is something rare – but in groups, parties, nations and epochs, it is the rule.

Friedrich Nietzsche (1844 - 1900)

"Our problems are not so much in finding new ideas as in escaping from old ones."

John Maynard Keynes

"The greatest leverage for improvement lies not in changing the way we work, but how we think."

W. Edwards Deming

¹ Donella Meadows, "System dynamics meets the press", *System Dynamics Review*, 5, Winter 1989, pp. 69-80. The column to which she refers is included in the section on "A systems perspective of the free market."

² Kuhn, T. S., *The structure of Scientific Revolutions*, Univ. of Chicago Press, 1970

In the editing I've found many of things in early drafts that were incorrect or incomplete, and I expect I will continue to find other things that are wrong. I expect you will, too. I will appreciate being informed of the errors you find.

This paper has been a much greater investment than I ever intended to make. I guess I've done so for three reasons:

- In addition to important environmental and sustainability issues, many lives are negatively affected by the problems related to growth and the zero-sum-games that promote uneven prosperity at best.
- The systems approach is the way to think about complex problems. Despite its power, it has not caught on as is warranted. Perhaps, by applying it to an issue that people care deeply about, it will promote its use for addressing other societal and organizational issues.
- Yes, it's a mess; but it's a really fascinating mess.

Bob Powell
Colorado Springs, CO

"Why isn't system dynamics spreading like wildfire?"

"We live in institutions whose fundamental way of being is antithetical to the tools ... other than that no big problem."

Peter Senge - author of *The Fifth Discipline*
1996 Power of Systems Thinking Conference

"We live in an era of massive institutional failure."

Dee Hock - Founder and CEO Emeritus
of VISA USA and VISA International
1996 *Systems Thinking in Action* Conference

A brief introduction to systems thinking

Why systems thinking is important

Societies, organizations, and persons are systems. The essence of the systems approach is to understand the “structure” of the system by understanding the relationships and interactions between its parts.

What is systems thinking?

Seeking to understand system behavior by examining “the whole” ... instead of by analyzing the parts.

The premise, a key principle of system dynamics, is that *the behavior of the system is determined primarily by its internal structure, not by external influences*. It’s not that external influences do not affect system behavior, it’s that first we look for how the system itself may be creating (or will create) behavior. When an external influence is considered, the premise is that the system’s response to that external influence is determined by its internal structure, not by the external influence. “Structure” is used in a very specific way in this context; it consists of the influences of system variable on each other. For example, all else being equal, increasing “travel time” decreases the “attractiveness of driving.”

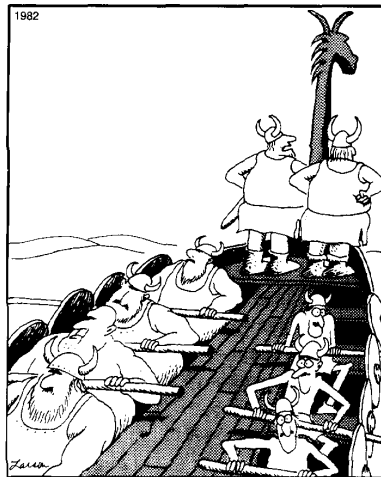
Because everything is connected to everything else, we can’t simply “map or model the system.” Determining the boundary of the system is a major, but necessary, challenge. We establish a system boundary by defining the problem to be addressed, not the system to be understood.

What is structure?

The influences and interdependencies among actions and measures, *including feedbacks*, that determine system behavior.

What is feedback?

In this context, it is not “constructive criticism.” It’s when changes in one part of the system affect other parts of the system, which in turn come back to affect the original part.



“I’ve got it, too, Omar... a strange feeling like we’ve just been going in circles.”

An Example of Structure

So the Viking says, “I’ve got it, too, Omar ... a strange feeling like we’ve just been going in circles.”

This cartoon illustrates a critical concept. The Vikings have a mission, and they have a vision of where they want to go. But mission and vision aren’t enough. They must turn around to look at structure to understand the behavior they’re experiencing. Unless they do, they cannot fulfill their mission and achieve their vision. Once they understand the structure, they can design policies to create their desired behaviors and outcomes.

understand structure

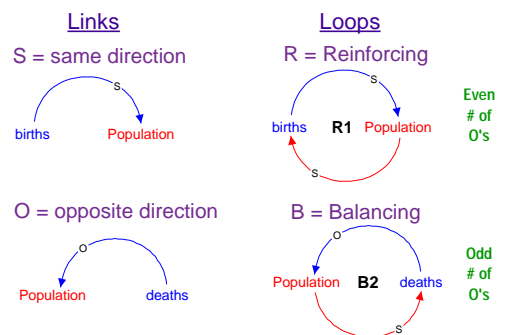
understand behavior

design policy

The language of causal loops

- An “S” means an influence in the “Same” direction, e.g., more sales gives more revenue ... or less sales gives less revenue.
- An “O” means an influence in the “Opposite” direction, e.g., more “customer service demand” gives less “service quality” (all else being constant) ... or less “customer service demand” gives more “service quality”.
- Loops are reinforcing if there are an even number of “O” links (zero being an even number). The action of a Reinforcing Loop is to increase or decrease the amplitude of the behaviors associated with the loop.
- Loops are balancing if there are an odd number of “O” links. The action of a Balancing Loop is goal seeking, to decrease the variations in behaviors associated with the loop (though large oscillations can result if there are long delays).
- A double slash, or “equals” sign, on a link indicates that it has a significantly longer delay than the other links.

The Systems Thinking Language



Reinforcing Loop



Balancing Loop



How to read the diagrams

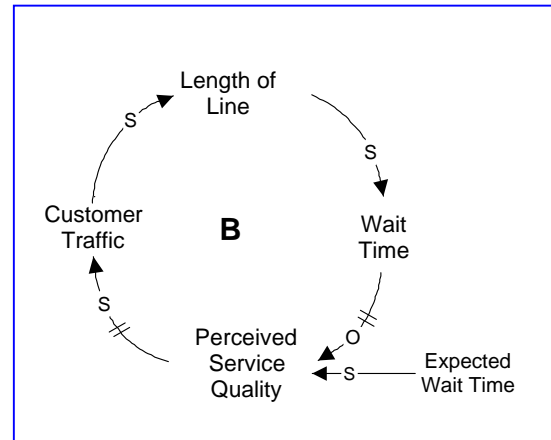
Though some of the diagrams are complex, they are relatively simple to read. The loops in the diagrams are essentially stories; follow the arrow links to read them. As an example, at right is a diagram that goes with this story:

"That place is too popular. Nobody goes there anymore." Yogi Berra

The diagram reads like this.

- More "Customer Traffic" creates a *longer* "Length of Line."
- A *longer* "Length of Line" creates *more* "Wait Time."
- More "Wait Time" results in *lower* "Perceived Service Quality."
[Note "Wait Time" is compared to "Expected Wait Time" to determine the "Perceived Service Quality." The *greater* the "Expected Wait Time," the *better* the "Perceived Service Quality."]
- Less "Perceived Service Quality" creates *less* "Customer Traffic."

In this case we started with more "Customer Traffic" and completed the loop with *less* "Customer Traffic." The diagram's "story" can also be told in the opposite sense, starting with *less* "Customer Traffic," etc., and ending with *more* "Customer Traffic."



This is an example of a "goal-seeking" balancing loop, where going entirely around the loop creates an influence that counteracts the initial change. A balancing loop's action is similar to that of a home heating system with a thermostat; in this case "Expected Wait Time" is the thermostat setting. A thermostat-like reference is present for all balancing loops, either explicitly or implicitly. This diagram shows that "Customer Traffic" increases until "Wait Time" equals the "Expected Wait Time." If "Wait Time" increases above the "Expected Wait Time," the influence will cause "Customer Traffic" to fall back to a level where "Wait Time" equals "Expected Wait Time" ... or perhaps oscillate about that level.

In the case of a reinforcing loop, going around the entire loop produces an action in the direction of the original action ... it reinforces to produce an increasing or decreasing response (an increasing feedback example is the squeal of sound system feedback). Reinforcing loops are two-edged swords; they can be either virtuous or vicious cycles.

Why do loops matter?

Loops matter because nothing grows without a reinforcing process ... and nothing grows forever, because limiting actions of some kind always arise. These loops are structure. As noted above, though there are outside forces that act on the system, the response of the system to those external influences is determined by the structure of the system. Unless we understand the reinforcing and balancing feedbacks, the drivers of behavior, we cannot design policies to produce the behaviors we desire.

The diagrams form a "theory of the system." Theory is not just academic; it is very practical. The word "theory" comes from the same root as the word "theater" ... both are ways of displaying our thinking. Systems thinking is an especially useful lens through which to gain insight; and it creates a framework for productive dialogue. Talking about the issues in the context of the diagrams can be very powerful. Beyond that, it is productive to create a system dynamics model, gather data to populate the model, then engage in simulation, testing, and dialogue ... and iterate and iterate and

Questions to ask:

- Does the structure have the potential to create the behavior observed?
- Is there disagreement about the influences in the model? If so, the disagreement is an opportunity for learning. Often models can be altered to display the alternate competing effects ... with *both/and* thinking, rather than *either/or* thinking. In other cases, disagreement can point to data that's needed to resolve the dispute.

- What measures are we missing that are needed to track what's happening? There's so much data than could be taken, we need theory to guide us in selecting the data to collect ... the data that will be most useful in confirming or disconfirming theory.³
- Are there latent potential feedbacks that are not yet activated? They could affect the future behavior of the system.⁴

Models are always incorrect. They are only approximations, not the real thing. So they're not about their absolute correctness, but about their usefulness for as a foundation for dialogue and understanding the root of system behavior with respect to the problem being addressed.

³ Every measurement is guided by some explicit or implicit theory that tells us that the measure is important. Unfortunately, we often manage based on the measures we happen to have, rather than the measures that are important.

⁴ This points to a difficult aspect of modeling. Just because a model predicts the past does not mean it can tell us what will happen in the future. Dormant loops often become active and produce what we perceive as "surprising behavior." For this reason, using spreadsheets of past performance and projecting into the future with regression formulas is like driving while looking through the rear view mirror. This is a major weakness of econometrics.

Summary

Background

The Problem: How can we explain why growth produces traffic congestion, infrastructure backlogs, higher taxes, declining quality of life, consumes farmland, raises costs (including the cost of housing, making it unaffordable), and sprawl.

The Approach: A systems thinking approach is appropriate for understanding why a system behaves as it does (see previous section).

A Premise: Because we see similar problems (though at different stages of evolution) all across the country, it's a major hint that the roots of the problem associated with growth and sprawl are driven, at least in part, by national policy and by similar state and local policies.

What's presented here: The major structures that interact to create the behaviors we observe and data relevant to the structures.

Suggestions on how to read this paper: First, start by reading the brief summary below. Before reading the next section on "The diagrams," be sure you've read "A brief introduction to systems thinking" so you'll know how to read the diagrams. They're off-putting, I know (especially Figure 2), but it may help to look at the loops as simply a way to tell stories about how influences play out in the system. They really are fairly easy to read once you get the hang of it. If it's any consolation, they are a whole lot easier to read than to create. Printing the diagrams can provide a useful reference as you read.

After that, if you can read the whole paper straight through, good for you. If that looks like too much, you could read the solutions section ... going from there to the more detailed material in main paper that's of most interest. Or, simply start reading in a section in which you are most interested.

If you think you've found a mistake in one of the diagrams, you very well may have ... I do every almost every time I look at one I've created. Make a note and let me know if you would. I've attempted to include what I think are the major effects, but I don't pretend that all effects are shown in the diagrams; you'll surely see ones that are omitted, which doesn't mean at all that I would think they're invalid.

Influences on Sprawl:

Figure 1 shows six of the influences on sprawl (as well as the influence of sprawl on "Demand for Gasoline"). There are, of course, surely other influences on sprawl. This diagram illustrates two things.

Influence vs. Exposure:

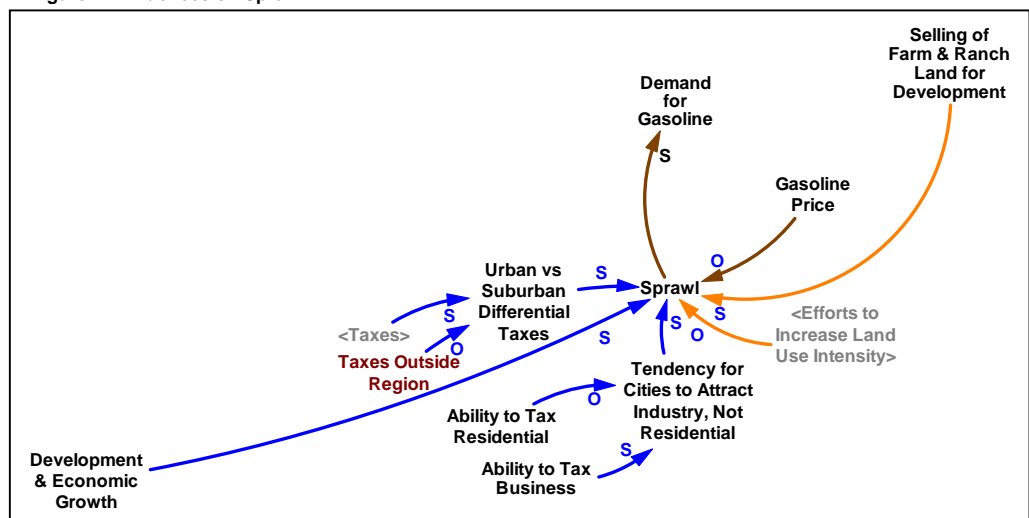
First, there are many influences on sprawl. That makes it a high "exposure" variable. It's very difficult to attack a high exposure variable directly; there are

so many influences that it's virtually impossible to control them all. What we want to find are variables with high "influence" and low "exposure." "Road building" in Figure 2 is such a high influence variable.

"... you can analyze the whole into its constituent parts, and that's a completely valid endeavor. But then you have parts, not the whole. You can take a watch apart and analyze its parts, but they won't tell you the time of day. ... The wholeness ... is not found in any of [the] parts, and that puts an end to a certain reductionistic frenzy that has plagued Western science virtually from its inception."

Ken Wilber, *A Brief History of Everything*, 1996, p. 25.

Figure 1. Influences on Sprawl



Causes: Second, while Figure 1 shows us some of the influences, it tells us little about the causes. Sprawl is a symptom for which we wish to understand the causes. The causes of the behaviors we observe are internal feedback loops that drive systems behavior. In some cases an internal feedback is set in motion by external influences (such as Federal and State road building) ... the internal feedback might be dormant otherwise. This means that an effective solution must either change internal policies to neutralize or break the internal feedback loops or else change the external policies so that they no longer provoke the action of the internal feedback loops in the same way.

A brief overview of the overall dynamic

This section attempts to describe the main stories shown in Figure 2.

Based on its fear of setting off an inflationary wage-price spiral, the Federal Reserve maintains policies that assure there are fewer jobs than people. Because only so much economic growth is allowed, people and regions must compete for the jobs and growth that are possible; and the competition escalates. People are led to be willing to do work for less pay. Regions attract companies by offering ever more “business friendly” environments with lower taxes, less regulation and weaker worker protections. These situations parallel each other in that the escalation drives both peoples’ wages and regional taxes, that might be called “regional wages,” toward zero. A minimum wage was established because wages are driven toward zero. Too often these wages are not a “living wage” in that people cannot afford basic services, such as housing and health care, and regions cannot afford to maintain infrastructure and services.

As regional infrastructure backlog grows and services decline, regions are led to promote more development in order to gain tax revenue. This provides some immediate relief, but years later the increased load on the infrastructure creates an even larger backlog. This prompts regions to promote even more growth for more immediate relief. This is called “addiction.” It is the same structure as addiction to drugs: feel good in the short term even though long term health suffers. Because there’s a long delay before the infrastructure demands arise, it’s easy to ignore, and/or obfuscate, the connection. Of course, addiction of any kind is not a solution. No one can sell a product at a loss and make it up in volume.

One aspect of the infrastructure backlog is traffic congestion. There is only so much road capacity, it is a “commons” that becomes overloaded by the continuing development. This leads to pressure to build more roads to relieve the congestion. Federal and state investment in roads in response to the pressure can help for a short time, but this makes driving more attractive, which induces more traffic in more trips and longer trips. The improved access makes the region larger, which provides better access to the hinterlands, making more growth possible with the increased traffic that accompanies it. And a larger region makes existing public transportation less adequate and leads more people to make the choice to drive. This leads to an upward spiral of traffic congestion, road building, and growth ... and to a death spiral in the use of public transportation.

The preference for driving relative to public transit is also reinforced by a low price of gas that does not take into account the cost of all of the negative externalities associated with driving (e.g., health problems due to pollution). Additionally, the eventual costs that will be associated with redesigning/retrofitting a region that depends on low gas prices is not taken into account.

Continuing regional growth leads to speculation that land prices will rise, and even to “structural speculation” that promotes specific road building and annexations to *assure* land prices will increase. Tax policy also increases speculation. Speculative profits are often taxed as long term capital gains and major expenses (such as property taxes and mortgage interest) can be deducted from income. Allowing deductions for depreciation of property (as if it were “used up”) not only reduces taxes, it artificially increases the “churning” of property that drives up demand. Churning is advantageous because, as property depreciation allowances decline with time, entrepreneurs sell each other the same stock of properties on approximately five-year cycles. These distortions drive up land prices (...in addition, they divert investment from the actual production of goods and services).

Other forces reduce the value of land for farming and ranching. Because farm and ranch capacity is so large and because efficiency is so great, commodity supplies far exceed demand. This depresses commodity prices. Switching to other crops or livestock may work for a while, but there is so much capacity that those markets are soon overwhelmed as well. Individual farmers and ranchers make the logical calculation that, if they can just produce a more and do so more efficiently, they can

make a profit; and besides, it does not seem to make sense to leave machinery and equipment idle.⁵ The additional increased supply causes prices fall even further. This decreases the value of land for the purpose of farming and ranching.

The dual forces of an “increased current land value for development” and a “decreased current value for farming and ranching” drive the selling of farm and ranch land for development, leading to growth and sprawl.⁶ Additionally, because the use of infrastructure is priced at approximately the average cost, rather than the marginal cost, there is little penalty paid for, and much to be gained by, leapfrogging further out into the hinterlands. It is more profitable to build where land costs are less: price pressure is less and profit margins are greater.

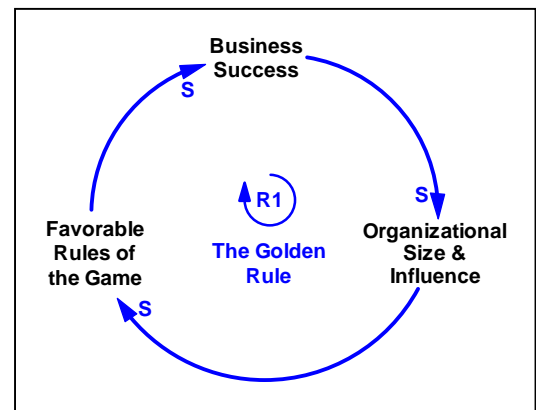
Caught between the dual pincers of low wages driven by Fed policy and ever-higher home prices driven by growth and speculation, affordable housing becomes less and less available. Homebuyers have incentives to “drive until they qualify” to find lower home prices in the hinterlands. This promotes sprawl and more traffic congestion.

Our region will continue to attract businesses (and therefore people) as long as it is more attractive than other regions. Attractiveness does not mean “pretty,” it refers to the composite of factors that “attract.” As quality of life falls from an increasing infrastructure overload, our region will become less attractive and immigration will slow. There are several reactions to the declining quality of life. One reaction is that, to pay for needed infrastructure, development interests call for taxes on the population. Another is that some taxpayers call for impact fees and excises taxes on development. Others call for development approaches that use infrastructure more efficiently (such as mixed-use development and/or growth boundaries).

Growth and development provide rentiers⁷ (developers, builders, realtors, mortgage lenders, etc. ... those who profit from the increasing the exchange value of property) with income. Some of this income is “reinvested” in contributions to economic development, in campaign contributions to political candidates who share sympathetic points of view, and in advertising campaigns and other promotions. This is to lobby for favorable regulations, for tax increases (in lieu of impact fees) to pay for infrastructure, and to increase the perception that growth is good. These investments lead to more growth, development, income and investments in a reinforcing cycle. John Sterman, in a section of *Business Dynamics* on “The Rules of the Game,” describes this feedback process.⁸

The larger and more successful an organization, the more it can influence the institutional and political context in which it operates. Large organizations can change the rules of the game in their favor, leading to still more success-and more power. [The Figure at right] shows the resulting golden rule loop [R1]. The golden rule loop manifests in many forms. Through campaign contributions and lobbying, large firms and their trade associations can shape legislation and public policy to give them favorable tax treatment, subsidies for their activities, protection for their markets, price guarantees, and exemptions from liability. Through overlapping boards, the revolving door between industry and government, and control of media outlets, influential and powerful organizations gain even more influence and power. In nations without a tradition of democratic government, these loops lead to self-perpetuating oligarchies where a tightly knit elite controls a huge share of the nation's wealth and income while the vast majority of people remain impoverished (e.g., the Philippines under Marcos, Indonesia under Suharto, and countless others). The elite further consolidates its control by subsidizing the military and secret police and buying high-tech weaponry and technical assistance from the developed world to keep the restive masses in check. Even in nations with strong democratic traditions these positive loops can overwhelm the checks and balances designed to ensure government of, by, and for the people.

The Golden Rule: Whoever has the gold makes the rules.



It might be noted that the portion of the structure associated with the growth machine is not shown as a majority of the structure. However, explicitly showing potential linkages from economic and political power and how it affects beliefs and other high-level government policies could expand the apparent influence of these actors (see “About beliefs”).

⁵ It's logical that each individual wouldn't calculate that producing less would provide more income. Now, if *everyone* agreed to produce less, this would work, but there are too many producers to organize. Besides, there are laws against cartels; and even if they were allowed, there would always be some who would “defect.” Even OPEC, with many fewer producers, has this problem.

⁶ Net Present Value (NPV) calculations devalue the future returns from farm and ranch land so greatly that its value to future generations can be neglected by standard financial analysis.

⁷ Economists use of the term “rents” extends to profit on the sale and exchange of property, not just on rental income.

⁸ John D. Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill, 2000, p. 380.

These major stories are described independently. But as can be seen in Figure 2, they're highly interdependent.

The winners in this structure are:

- **Rentiers:** Growth increases the returns from the ownership, sale, and exchange of property.
- **Other property owners:** While increasing property values are not necessarily their main interest, they do benefit from increasing property values.
- **Road building industries:** More traffic congestion and growth leads to calls for more road building.
- **Immobile, volume dependent businesses:** These include newspapers, utilities, even universities.
- **Corporations:** They get low taxes and low-regulation environment, which increases returns to stockholders.

The above interests are described as “naturally organized” by the profit motives they share.

The losers are:

- **Renters:** Renters see increasing rents, but do not participate in the gains from increasing property values.
- **“Use value” interests:** Those whose interests are “use values” – that is, those in businesses not involving the exchange of property – lose quality of life.
- **Regions that wish to maintain quality of life:** Regions are set against each other in a zero-sum-gain competition for the economic growth that is allowed by Fed policy. This decreases regional ability to collect taxes and maintain environmental and worker protections.
- **Unions:** Workers and unions in different regions are set against each other in a zero-sum-gain competition for the jobs that are allowed by Fed policy. They are convinced by logical arguments that growth-friendly policies are necessary to create jobs, though such policies only affect the distribution of jobs. Higher growth rates do not significantly affect unemployment because workers are drawn from other, slower-growing regions (see data in the section “[Federal Reserve policy, wages, and growth](#)”). What the policies do accomplish is to depress wages, reduce worker protections and reduce overall quality of life.
- **Neighborhoods and neighborhood organizations that attempt to maintain quality of life:** They are called NIMBYs.
- **Public transportation advocates:** A growing infrastructure backlog means there will be no funds for transit.
- **Affordable housing advocates:** With Fed policy depressing wages, rising home prices due to growth and speculation, and increasing pressure on government to pay for infrastructure there will be no funds for public subsidies for low wage workers or for renters comparable to those for homeowners.
- **Environmentalists:** Business-friendly policies to attract companies are generally taken to stress the need to reduce or eliminate regulations that protect the environment. (This could change if “business friendly” is recast to emphasize maintaining quality of life to attract high-wage workers who have skills in high demand and who can choose among regions.)

These interests are described as “naturally disorganized” because they cannot make a direct profit from lobbying for their interests⁹ ...instead they can only attempt to minimize their losses.

Depressed yet? The structures are so powerful that it all seems quite overwhelming. If we do not recognize these structures and their enormous power and then do something to change them, we are condemned to a hell of our own creation.

But there are things that can be done; see the section on “[Solutions](#)”.

The diagrams

About “The Tangle of Growth” (Figure 2): Visually it's obvious that the issues surrounding growth are more than a problem, they're a real mess. It's clearly a “tangle.” This diagram is somewhat different from any I've seen. I've created it as a shorthand way of describing the dynamics.

The framework: Based on our *Beliefs* we create *Policies/ Effects* that produce other *Effects* that then act through *Systems Structures* to produce more *Effects*. These *Effects* then feed back on themselves to create the symptoms we observe.

The different elements of the diagram are:

- **Beliefs, paradigms, or mental models** – The statements don't necessarily mean that a belief is right or wrong, though you may have definite opinions about that. And, of course, you can probably find someone with exactly the opposite belief. The purpose here is to make explicit the influ-

"The problems we have created in the world today will not be solved by the level of thinking that created them."

Albert Einstein.

⁹ Unions would be an exception in that they would increase returns to their members.

ence of a belief. The statements only mean that, for an “S” link for example, the greater or lesser the belief, the greater or lesser the effect on the linked element of the diagram.

- **Profit motives** – The natural tendency to want to make a profit on business.
- **External conditions** (e.g., another region's attractiveness) – Conditions over which we have no control.
- **Policies** – Policies are adopted based on the beliefs, profit motives, or external conditions that influence them.
- **Effects** – These are outcomes that result from policies.
- **Archetypes/structures** – The diagram elements in boxes are the structures through which the policies, effects and external conditions act to produce other effects. These structures, some of which are fairly complex, are described in detail in the paper. This is simply a shorthand way of conveying the action of effects working through structures to produce other effects. The structures (systems thinking archetypes) include:
 - John Sterman's "fixes that fail" model of traffic congestion and the death spiral of public transit.¹⁰
 - The "tragedy of the commons" archetype.
 - The "escalation" archetype.
 - The "addiction" archetype.
 - The "attractiveness principle" archetype.
 - The "eroding goals" archetype.

The Loops: Each loop is somewhat identified by specific colors; but, because some links are part of more than one loop, all loops aren't of just one color. Hopefully, the use of color gives enough hints to be helpful in tracing the loops. Portions of the diagram are separated out onto separate pages to make it easier to follow the loops (some are quite tortured ... taking even more time, I could probably have made them neater). The loops and chains essentially tell stories about how the influences play out in the system. The stories are described in detail in the main body of this paper.

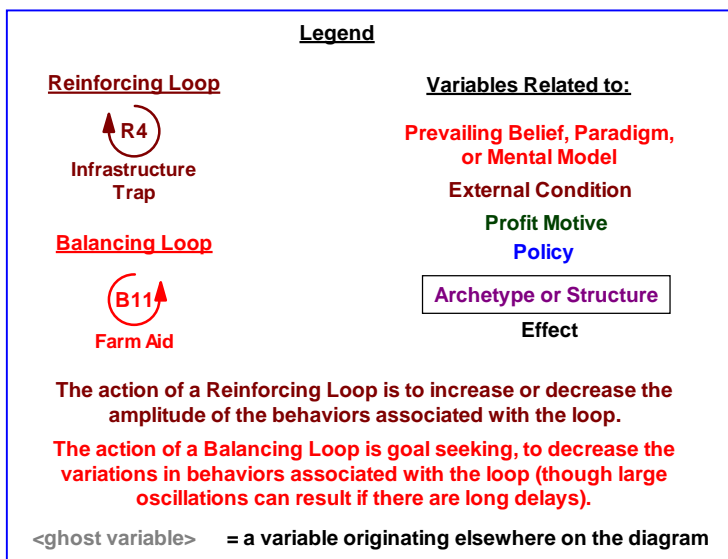
Here is a brief description of each of the

- loops identified on the diagram
- causal chains for those structures which come from beliefs and are not shown as part of a loop.

Fear of Inflation, Phillips Curve Chain Effect on Wages Chain: The Federal Reserve policy that assures there are more people than jobs leads to a “race to the bottom” spiral. Because “official” unemployment substantially underestimates those looking for more work and for higher level work, and because of the severity of the impact of this policy, people’s wages are driven down (toward and below a minimum wage). Game theory explains that the effect is more severe than one might think, because the policy creates a game of “musical chairs” where the “added value” of any one person is theoretically zero ... that is, “If you don’t take this job at this pay, there’s someone else who will.” It creates a zero-sum game. This helps create the low income side of the affordable housing crisis.

Fear of Inflation, Phillips Curve Chain Effect on Taxes Chain: In the same way this policy drives down wages, it drives down regional taxes and regulations. Because there is only so much economic growth to go around, companies can say, “Give us a deal, or we’ll go elsewhere.” The “added value” of any one region is theoretically zero. This creates a situation where regions do not have enough taxes to pay for infrastructure or regulations that to protect the environment, quality of life or worker safety. This also is a zero sum game between regions (rather than between workers); regions are pitted against one another. In a very real sense, taxes are the counterpart of “wages;” they allow regions a certain quality of life.

R1 – Infrastructure Trap: When taxes and fees do not cover development costs, it is very tempting to “solve” the problem, at least in the short run, by promoting more development. The region gets the taxes on building materials and employee spending, which increase regional income. However, in 3 – 5 years, there are additional demands on the infrastructure that



¹⁰ John D. Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill, 2000, pp. 177 – 190.

need to be addressed, which sets up the need to promote even more growth to pay for that. This structure is the same as the structure of addiction to drugs.

B2 – Attract Until Unattractive: This process cannot go on forever. One of the limitations is that, as the infrastructure backlog increases, it has a negative impact on quality of life, which decreases the attractiveness of our region, which reduces our economic growth. [One loop that is omitted here (and should be added) is that, sensing the downturn, there are increased pressures to again lower taxes and regulation to be even more “business friendly.”]

B3 – Road Building: One action to address the infrastructure backlog is to build roads. This is a balancing process that aims to correct the deficiency.

R4a, b, c – Induce Traffic by Economic Growth, Region Size, Driving Attractiveness: Unfortunately loop B3 is a “fix that fails.” More economic growth under the conditions described above, where infrastructure costs are not fully covered, further increases the backlog. More road building increases the size of the region, which creates more traffic volume, which causes more traffic congestion and creates a larger infrastructure backlog. Also, more road building makes driving more attractive, inducing more trips and longer trips to also increase traffic congestion.

R5 – Transit Use: As if this weren’t enough, as the region gets larger, public transit is less adequate. This also makes driving more attractive and leads to more congestion ... another failure of the “road-building fix.”

“There’s a Glut of Oil” Chain: Belief that gas prices will remain low, and that the long term cost of a transition from oil to other forms of energy is negligible, leads to a lower apparent cost of driving, to the belief that public transit is too expensive, and to less investment in public transit. This makes driving relatively more attractive and leads to more traffic congestion.

B6 – Sprawl and Gas Price: The belief that there are plentiful oil supplies into the foreseeable future keeps gas prices low, and makes it more feasible to live further out, feeding sprawl. This loop would limit sprawl if gas prices were not kept low (by plentiful oil wells): more sprawl would increase the demand for gasoline, raise the price of gas, and thus limit sprawl.

“Free Market Balances Supply and Demand even when Inelastic” Chain: Because there is so much farm commodity supply relative to demand, prices are low. Each farmer, acting independently and rationally, believes that the way to get more income is to put more acreage into production and be more efficient. Unfortunately, everyone doing this increases supply and leads to even lower prices. The “Freedom to Farm” act passed in 1996 unleashes this dynamic with a vengeance. The low commodity prices lower the value of the land for farming and increase the selling of land for development.

B7 – Farm Aid: To balance this falling income, price supports keep prices higher in an attempt to raise prices high enough that too many farms don’t fail financially.

Growth is Good, Growth “Pays for Itself” Chain: This belief leads to growth-friendly government policy.

R8 – Land Values Will Rise: Some see growth as a sure thing that will eventually make land in the hinterlands more valuable. This speculation increases the demand and increases the value of land for development, which leads to more farmland being converted to development, which leads to more growth.

R9 – They’ll Drive Further: The less affordable housing, the further out people will drive to find an inexpensive home, which increases demand and increases the selling of land for development. This leads to more growth and more speculation and to even less affordable housing.

B10 – Construction Innovation: A higher cost of housing should lead to more innovation that would act to reduce costs. Note that if impact fees increase pricing pressure, this loop should help keep prices from rising as much as they otherwise would, just as Japanese competition gave Detroit incentive to improve cost and quality (though they have not yet achieved the quality and costs of this competition).

B11 – Citizen Pressure on Fees: When the rate of increase in infrastructure backlog is high, with a consequent rapid degradation in quality of life, citizens apply pressure for impact fees to stop the decline.

B12 – Tax to Support Development: As quality of life decreases, growth interests realize it is threatening their ability to do business and they support tax increases to help address the backlog.

B13 – Mixed Use: Another (very long term) response to a rising infrastructure backlog and a falling quality of life is to push for mixed use development to reduce infrastructure costs. A push for growth boundaries that would make more efficient use of existing infrastructure could also be added here.

B14 –Need Taxes for Quality of Life: As our region is attractive compared to other regions, our region attracts more economic growth, which increases the infrastructure backlog, and decreases the quality of life. This increases pressure for taxes, which decreases our region’s comparative attractiveness.

B15 – Need Fees for Quality of Life: Increasing fees would have a similar effect.

B16 – Housing Costs Rise: As would higher housing costs.

R17 – Bigger Region Needs More Roads: More development and economic growth on farm and ranch land leads to more demand for improved roads, which makes farm and ranch land more valuable, leading to more growth and more roads.

R18 – Development Profitability: Profitable development provides funds to influence government policies to be more favorable than they otherwise would be; this keeps impact fees down, which leads to a larger infrastructure backlog, which leads to pressure for more growth (to provide short-term tax benefits), which again increases profits.

R19 – Growth Machine Influence on Growth: Profitable development provides funds for economic development to fuel the competition between regions.

R20 – Growth Machine Influence on Fees: Profitable development provides funds to influence government policies to be more favorable than they otherwise would be; this keeps impact fees down and decreases pricing pressure to keep profits high.

R21 – Land Use Intensifies: Land use intensification makes land more valuable and fuels development profits.

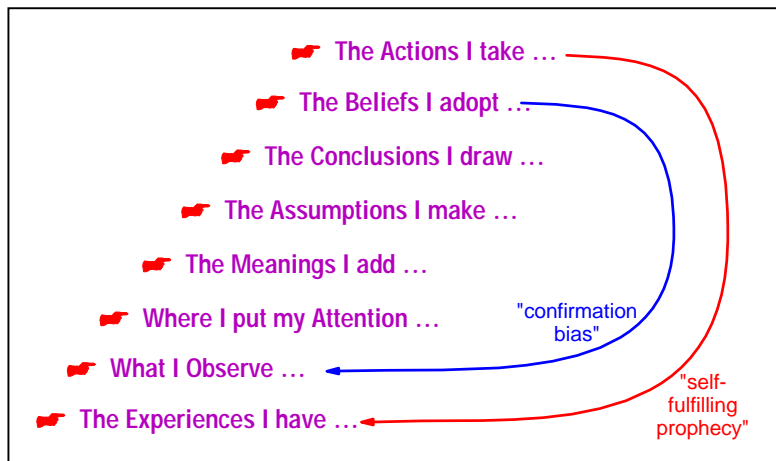
These last four loops are the essence of “the growth machine.” For an explanation of this concept, see the section on “[The “growth machine” thesis.](#)”

About beliefs

That beliefs are not shown as part of loops doesn’t mean they’re not, in fact they are. Based on beliefs we are prone to select some data to pay attention to and some data to ignore, which reinforce our beliefs; this is “confirmation bias,” as shown in the diagram, “The Ladder of Inference.”¹¹ And, more than that, we take actions that lead to results that reinforce our beliefs; this is the “self-fulfilling prophecy” dynamic. These feedbacks produce powerful effects. They cause some facts to not be seen and some logic to not be understood.

Because beliefs do not exist separate and uninfluenced in the world, they are an important aspect of structure with various actors striving to maintain them and others struggling to change them. A useful extension of this paper would be to examine how various actors, such as the “growth machine,” influence beliefs to promote the growth dynamic.

The Ladder of Inference



¹¹ Peter Senge et al., *The Fifth Discipline Fieldbook*, 1994, p. 242.

Jonas and Wilson reflect on this in their book, *The City as a Growth Machine*:¹²

And the push to forge growth always has to work through prevailing sensibilities and visions of appropriateness. Take, for example, the city boosters whose actions Molotch has sought to understand. Their involvement extends to a complex pattern of intervention which insists upon articulating themes that seek to strike a responsive chord in mainstream thought. Their articulations are never isolated and above the fray but are always linked to the world of existent imaginings and dreams. In this sense, growth machine interventions -- often subtle and nuanced -- penetrate far corners of local life that tie growth stratagems to commonsense thought and taken-for-granted practice. Thus, power becomes wielded not through contextless articulations that foist power and a new way of seeing on an unsuspecting mainstream but through cultivating prevailing beliefs and values in an ongoing political intervention.

But these machines do not communicate simply by lining up pieces of language in the right order, bolting words together that represent fragments of reality. Rather, language is infused with politicized meanings and values whose usage simultaneously illuminates and blinds with the imposition of one gaze. In it is a politicized mix of manufactured presences, deliberate absences, contrived caricatures, subjective taxonomies. In this way, people come to be both edified and blinded by the seeing of issues, problems, and possibilities. As Barnes and Duncan (1993: 2) succinctly note, it is humans who decide how to represent things, not the things themselves, making these representations potential hothouses of contention that carry the realm of politics far beyond the conventional realms of programs, policies, and regulations.

¹² Jonas and Wilson, eds., *The Urban Growth Machine, Critical Perspectives Two Decades Later*, 1999, p. 9.

Figure 2. The Tangle of Growth

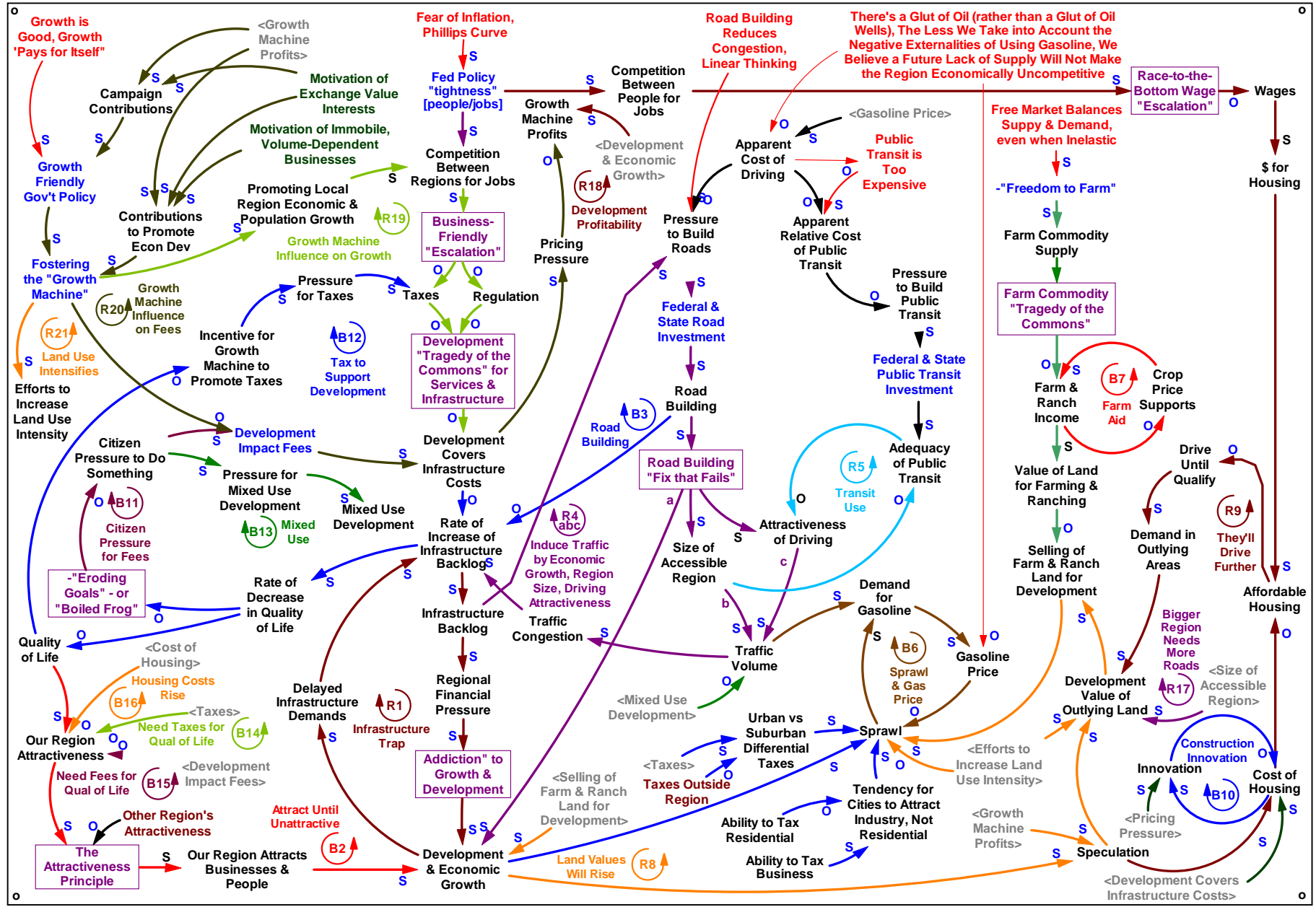


Figure 3. The Effect of Inflationary Fears, The Infrastructure Trap, & The Attractiveness Principle

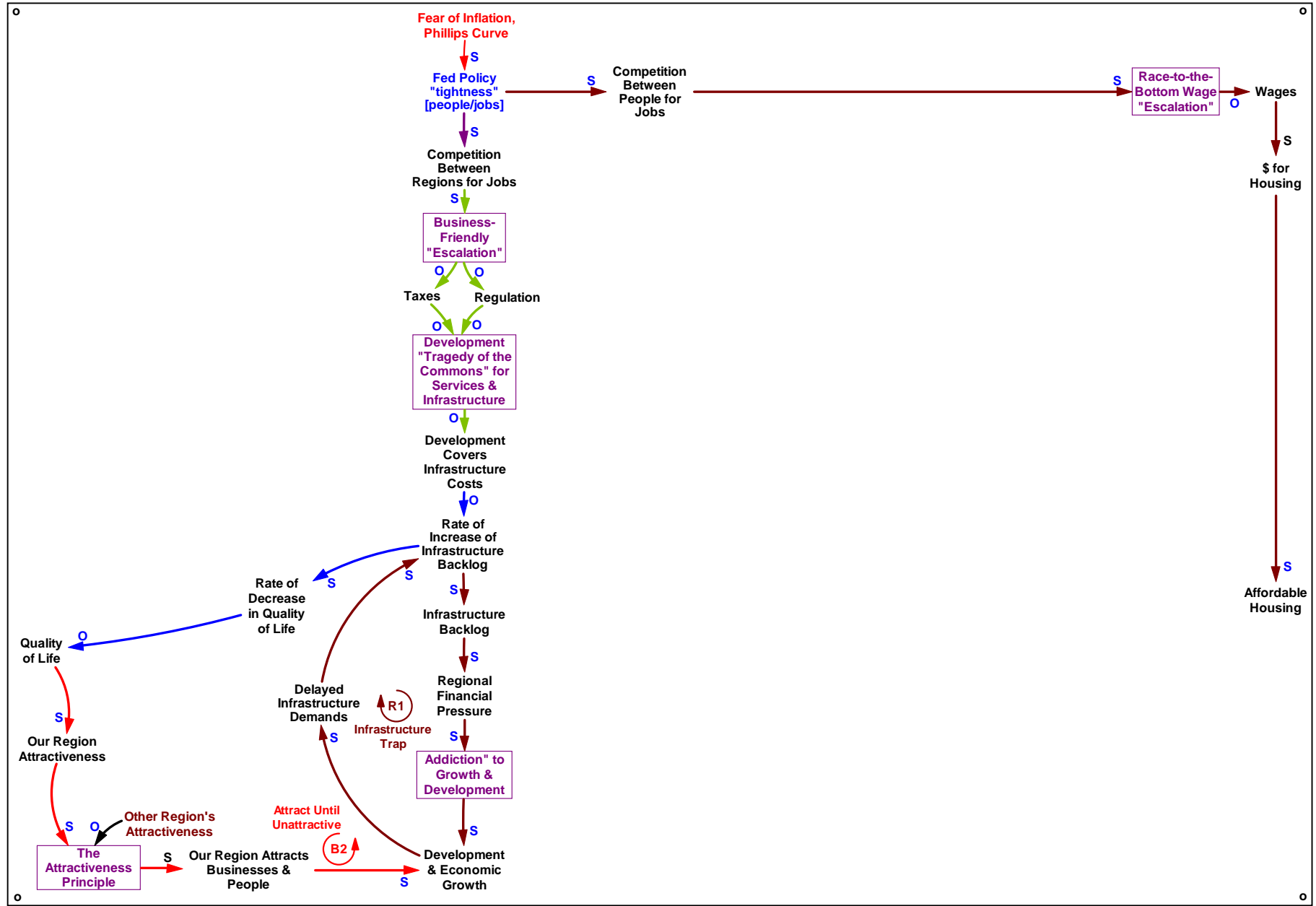


Figure 5. Devaluing Farmland, Farm Aid, Speculation Increases Development Value, Drive to Qualify for Mortgages, & Construction Innovation

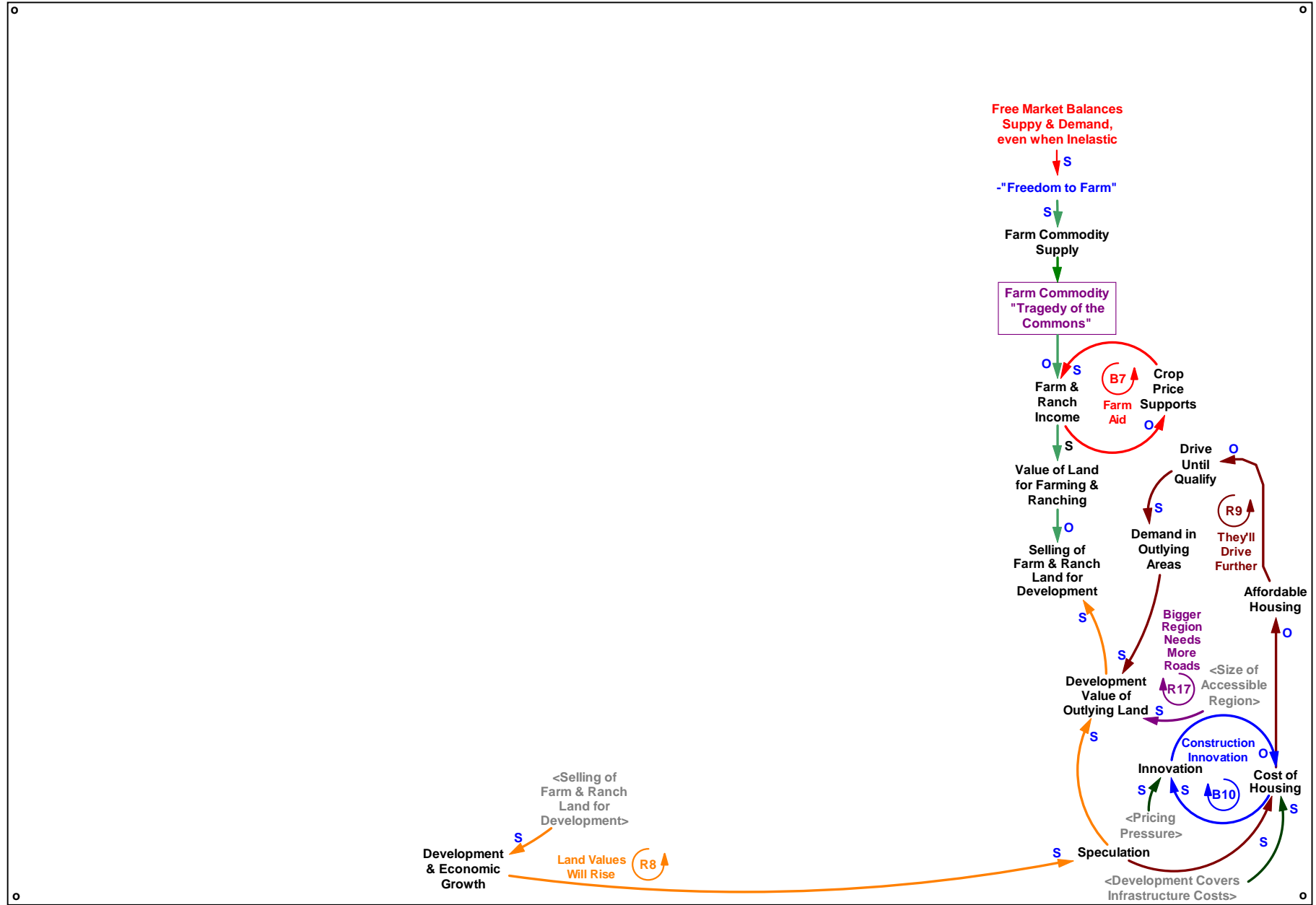


Figure 8. Road Building Creates a Larger Region and Increases Pressure to Sell Farmland

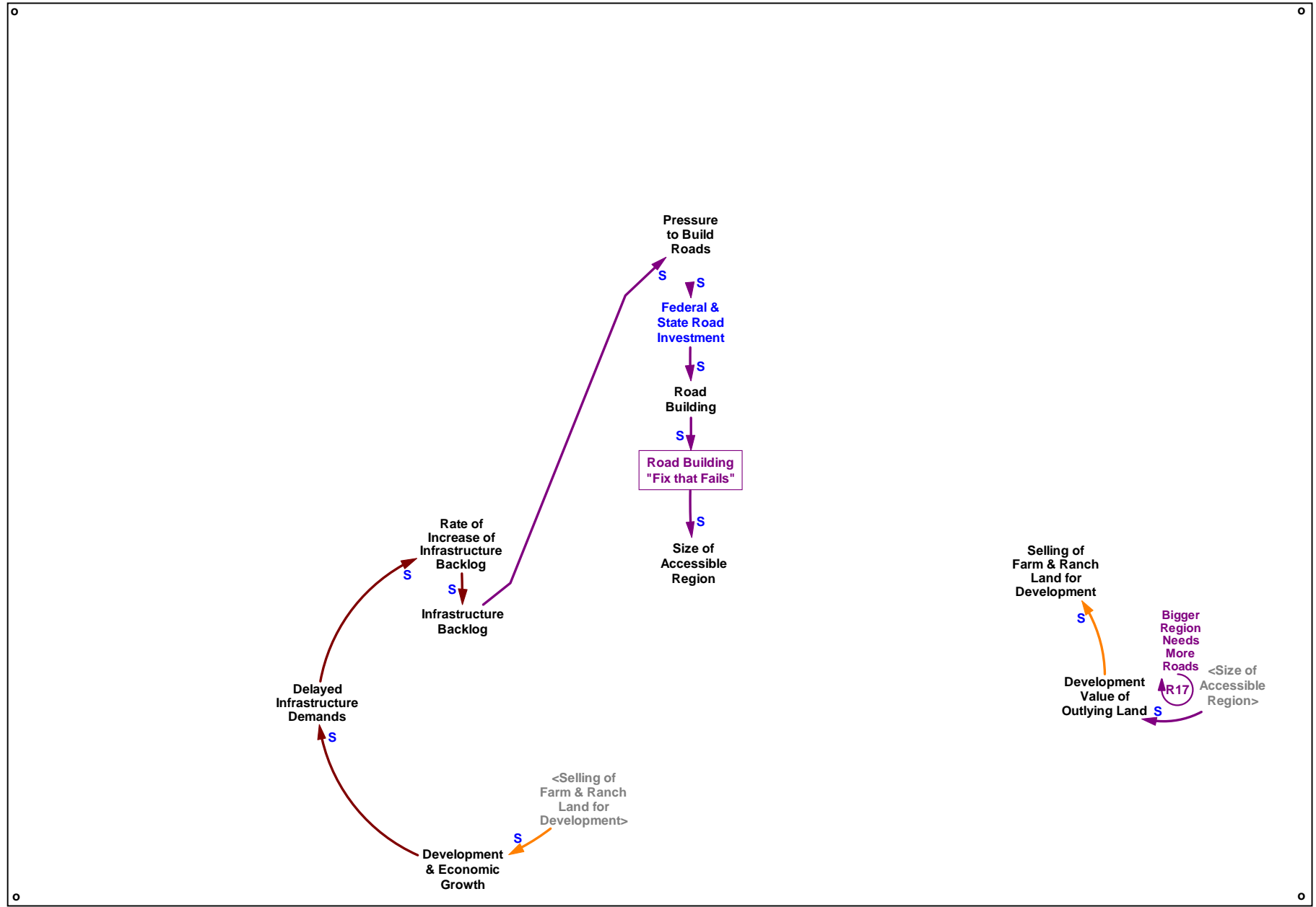
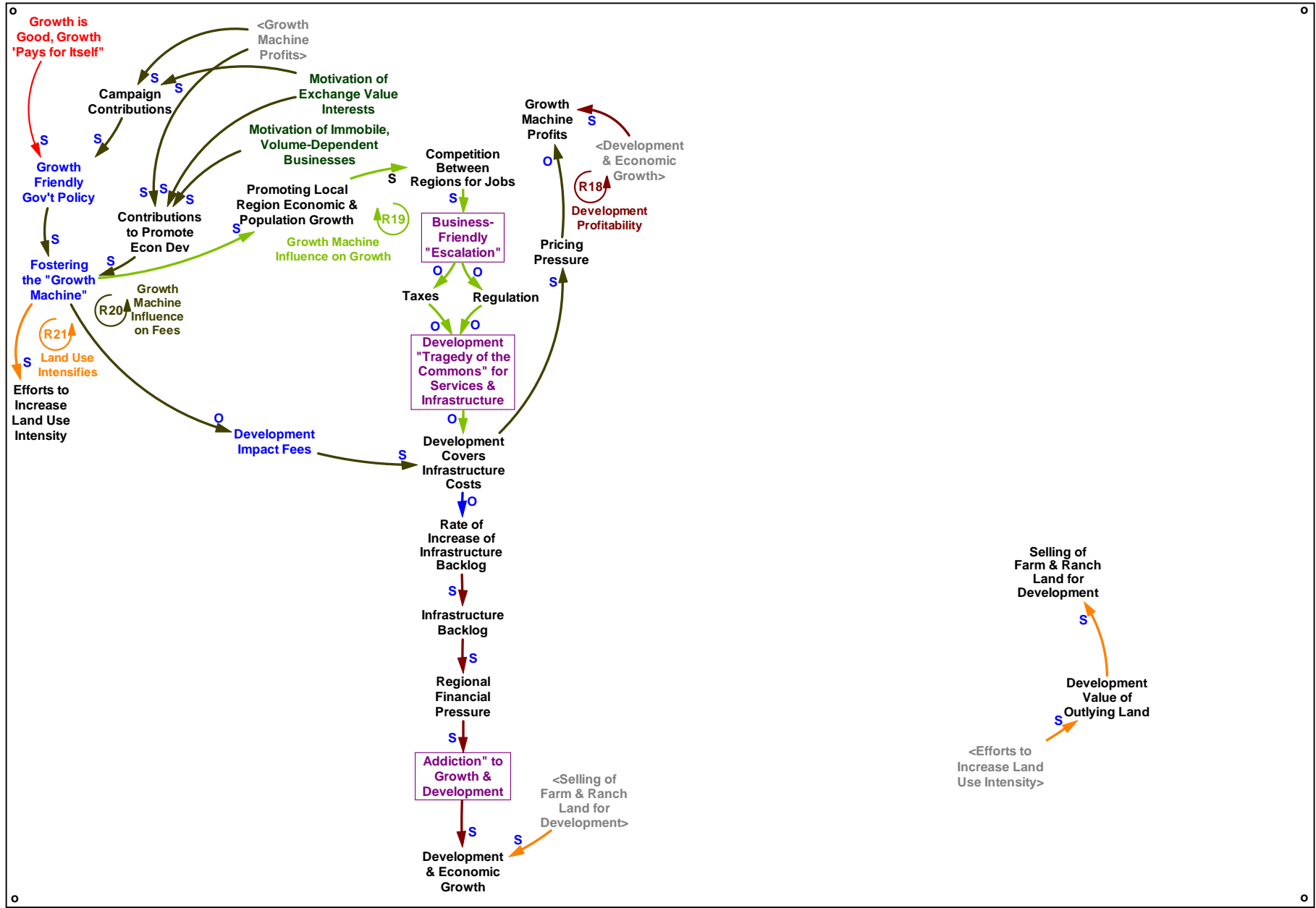


Figure 9. High Profits (from Not Having to Cover the Costs of Infrastructure) Fuel the Engine of Growth



The Tangle of Growth: A Dynamic Analysis

Introduction

The issues surrounding growth are complex ... and that's an understatement. Opponents of growth management, or growth limitations, often refer to "unintended consequences" as a basis for questioning limitations. However, political, economic and social "unintended consequences" of growth already abound. Our current policies affect growth, sprawl, housing prices, transportation congestion, infrastructure backlogs and many other observable problems in a variety of ways.

To understand why things are happening as they are, and develop effective policies, we must use systems thinking, rather than linear thinking. There are two reasons we need to make this shift: ¹³

First, our cognitive maps of the causal structure of systems are vastly simplified compared to the complexity of the systems themselves. Second, we are unable to infer correctly the dynamics of all but the simplest causal maps. Both are direct consequences of "bounded rationality" ... Axelrod¹⁴ found virtually no feedback processes in the cognitive maps of political elites; rather people tended to formulate intuitive decision trees relating possible actions to probable consequences – an event level representation.

So we tend to see only part of the structure and not be aware of feedback processes or their impacts. And this isn't just a problem for some of us; it's the human condition. We can improve our intuition in dynamically complex situations, but it takes practice. And even then, system dynamics modeling and simulation are most often necessary, because in most cases the system is just too complex. Professor Sterman notes the problem is similar to one where, even if we know the laws of physics, we cannot figure out in our heads what happens when galaxies collide.

Short of full-scale simulations, the system diagrams in this paper make it possible to *think together* about what's driving the behaviors we observe. It's not that the diagrams are proven truth; they're not. In fact, they're innately wrong in that they are an approximation at best. The main point is that they provide a way to think about such dynamically complex problems, to make that thinking explicit, and to make the communication of that thinking practical. The alternative of describing the dynamics in written paragraphs is extremely cumbersome.

Some of the models shown here are complex. That's because the problems are complex. I have made an effort to provide a logical rationale for their structure and I have "tested" them with several persons to see if the logic is reasonable and coherent.

But the main point is for others to test them against their own thinking and to change or enhance them to improve our understanding of the problems we face. A disagreement will not necessarily indicate an invalid point of view, but instead it will indicate that other valid effects should be included.

**Everything should be made as simple as possible,
... but not simpler.**

Albert Einstein, (1879 - 1955)

¹³ John Sterman, "Learning in and about complex systems," *System Dynamics Review*, Summer-Fall 1994.

¹⁴ Sterman reference: R. Axelrod, *The Structure of Decision: The Cognitive Maps of Political Elites*, 1976, Princeton University Press.