Creating a Business Cycle in Excel: Due April 16 by 11:59pm

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Keynes argued that fluctuations in investment created the business cycle and that it was the difference between expected and actual profits (combined with the panic that emerges in an uncertain world) that is the root cause. Michal Kalecki expanded on this.

A simulation can be created in just a few steps. First, the variables:

THEORETICAL MODEL
Exogenous

> K^*: The target stock of physical capital firms believe will be sufficient to meet market demand at an acceptable profit.
>
> Kd: The rate at which physical capital must be replaced to maintain the same level of profitability. This doesn't have to mean that it wore out-indeed, that every often will not be the case-but that's the easiest way to think about it.

Endogenous

> D_t: The decision made in period t regarding how much to invest in period t+1.
>
> I_t: Gross private domestic investment in period t.
>
> K_t: Stock of physical capital in period t.
>
> π_t: Actual level of profit in period t.
>
> π^e_t: Expected level of profit in period t.
>
> Panic: A condition triggered when actual profits (π_t) fall short of expected profits (π^e_t) by some predetermined amount.

Behavioral Equations

> (1) $\pi_t = I_t$
>
> (2) $\pi^e_t = \pi_{t-1}$
>
> (3) $K_t = K_{t-1} - Kd + I_t$
>
> (4) $Pnc_t = f(\pi_t - \pi^e_t)$; Panic penalty, triggered if $\pi_t - \pi^e_t \leq$ threshold then lower π^e_t by predetermined amount
>
> (5) $D_t = (K^* - Pnc_t) - K_t$ (values < 0 are treated as 0)
>
> (6) $I_t = D_{t-1}$

Underlying Logic

> I'm going to end up explaining all the relationships twice: here and in the section where I am laying out the Excel model. I know that's repetitive, but I figured you'd prefer that to maybe not quite understanding something.
>
> Equation (1) $\pi_t = I_t$: This is based on an Kaleckian idea that you have already learned: investors get what they spend. Today's aggregate investment spending (I_t) creates today's aggregate profits (π_t).
>
> Equation (2) $\pi^e_t = \pi_{t-1}$: Kalecki believed that one of the implications of Keynes' concept of

uncertainty (along with convention–we don't really discuss that one in class) was that economic agents tend to assume that, ceteris paribus, whatever is happening today will continue into tomorrow. Hence, the profits they expect today (π^e_t) are whatever profits were yesterday (π_{t-1}).

Equation (3) $K_t = K_{t-1} - Kd + I_t$: This one is pretty simple. The final value for period t's stock of capital (K_t) is equal to whatever it was when period t started (K_{t-1}) minus any depreciation that occurs over period t (Kd, which doesn't have a time subscript because it's a constant), plus any investment that takes place over the period (I_t). But there's actually a serious underlying problem here. There are stocks and flows in economics. A stock is like a bathtub full of water. A flow is the water coming in from the faucet or the water leaking out through the drain. Those are two different kinds of numbers. One (K_{t-1}) is measured in units like gallons. The other two (Kd and I_t) are gallons/unit of time. They are therefore not strictly comparable. Some computer modeling programs handle this very well as they are set up with it in mind. Excel isn't. It doesn't cause a fatal problem in our model here, but it's something to bear in mind. Kalecki did: " I have found out what economics is; it is the science of confusing stocks with flows."

Equation (4) $Pnc_t = f(\pi_t - \pi^e_t)$: This one is a trigger. If actual profits fall below expected by some predetermined value (a constant we will set later), then firms cut back on investment–a lot (the error of pessimism). How much? That, too, is a constant we will set later. Note that we could also include something like this for euphoria, where agents get too excited about how much higher profits were than their forecast; but it's really the panic that creates the shape of the cycle so I left it out.

Equation (5) $D_t = (K^* - Pnc_t) - K_t$: Kalecki thought it important to separate the decision to invest from the investment itself. In other words, you may decide in January to build a new restaurant, but then not break ground until June. The decision was in January and the investment in June (and July and August, however long it took). Equation (5) is just the decision itself, not the actual investment. It is assumed that the decision regarding how much to invest in the future is a function of the difference between the maximum stock of capital that entrepreneurs believe would profitable (K^*, a constant) and the stock of capital that will exist by the end of that period (K_t; not K_{t-1}, which is what it is at the start of the period, since it is assumed that entrepreneurs already know Kd and I_t) plus an adjustment for panic. With respect to panic, it is a predetermined value that represents the amount by which agents have temporarily reduced K^*, or the target stock of physical capital that they believe would be profitable, because they have become pessimistic. If panic was not triggered (see Equation (4)), Pnc_t takes a value of zero. If it is, then the value on D_t falls by some predetermined amount.

Equation (6) $I_t = D_{t-1}$: Today's investment was determined last time period.

Notable simplifications

This takes a number of shortcuts. For example, we have totally abstracted from the manner in which firms would estimate K*, we have taken no account of other variables that may affect investment spending (like interest rates), there is no change in population, and we have completely omitted the financial sector! But, the goal here is to see how few assumptions it takes to generate the instability Keynes and Kalecki believed existed. Furthermore, all those factors we omitted are likely to actually contribute to that, not dampen it.

But wait, there's more! It's actually very easy to set this up in Excel. So do so!

SIMULATION MODEL

First step, make your column headings. The rest of the directions will be easier to follow if you choose the same cell addresses as I did. Or, to make life even easier (what a country!), click here and you'll have an Excel file with all the headings already added:

http://personal.tcu.edu/jharvey/30233/ExcelBusCycleFramework.xlsx

It should look like this:

	A	B	C	D	E	F	G	H	I	J
1	**Post Keynesian Business Cycle Simulation**								**$ values in billions**	
2							**Panic Gap =**			
3			**K* =**		**Kd =**		**Panic Value =**			
4		**Actual**	**Capital stock.......**		**Profit....**				**Investment Decision**	
5	**Time**	**I**	**K**	**K* - K**	**π**	**πe**	**π - πe**	**Pnc**	**K* - K - Pnc**	**ProdFunc**
6	1									

I have marked in purple cells where you need to input some values for constants in the model. Put $43,000 in cell D3, $1200 in cell F3, $100 in cell I2, and $300 in cell I3. Those are the target stock of capital, the rate of depreciation, the gap necessary to induce panic, and the effect of panic. You'll see how those work later.

Next, we need some initial values. Put $1200 under I for first period investment; $40,000 under K for the actual physical capital stock in period 1; and $1200 under π^e for expected profits in period 1.[1] All of these will be calculated endogenously from period 2 on.

For the rest of the cells along row 6, input these formulas:

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[1] These numbers are based on the US macroeconomy over the period 1990 through 2014. Unless otherwise indicated, all dollar values are in billions of 2012 dollars and are from FRED.

D6	E6	G6	H6	I6	J6
K* - K	π	π - πᵉ	Pnc	K* - K - Pnc	ProdFunc
=D3-C6	=B6	=E6-F6	=IF(G6<-I2,-I3,0)	=D6+H6	see below

Here is the logic underlying each:

D6: This is the gap between the stock of capital that firms believe will be sufficient to meet market demand at an acceptable profit (cell D3) and the actual current stock of capital (C6). It is therefore what they hope to build as investment.

E6: According to the Kaleckian equations we did earlier, total profits equal aggregate investment. Whatever investment actually is in any given period (under column B), that's also that period's realized profits.

G6: We need to know the difference between actual (E6) and expected profits (F6) to see if agents replace their error of optimism with an error of pessimism! Whether they do are not is a function of how large the gap is, a question that will be asked in the next cell.

H6: Just because profits fell short of expectations does not mean that panic is induced. It depends on how much they fell short and, if they do fall short of that threshold, what is the impact? This cell says that if profits fall short of expectations by as much as what was input for Panic Gap (cell I2), then the consequence is that firms decide to reduce their investment plans by the Panic Value (cell I3). Note that we put those above the formulas so we could adjust them later and see what happens.

I6: So what will investment plans be for next period? Well, first of all, they want to close the gap between their target level of physical capital and the current level. They will only be able to close part of that gap in any given period (how much to be determined in cell J6). Also, however, we may have to lower that by the Panic Value. If we did not hit the Panic Gap, that value will be zero. Otherwise, it will be whatever we set for Panic Value (presently $300).

So far you should have this:

	A	B	C	D	E	F	G	H	I	J
1	Post Keynesian Business Cycle Simulation								$ values in billions	
2								Panic Gap =	$100.00	
3			K* =	$43,000.00	Kd =	$1,200.00		Panic Value =	$300.00	
4		Actual	Capital stock...............	Profit....					Investment Decision	
5	Time	I	K	K* - K	π	πe	π - πe	Pnc	K* - K - Pnc	ProdFunc
6	1	$1,200.00	$40,000.00	$3,000.00	$1,200.00	$1,200.00	$0.00	$0.00	$3,000.00	

J6: The last cell is setting limits on how low or high investment can be. Just because firms want to close the gap entirely between the current and target stock of capital does not mean that they can. Since it's gross and not net, it can't be negative. Furthermore, there must be some upper limit to how much can be produced in any given time period and that relationship would likely be non-linear, based on the positively-sloped s_k curve from the Davidson capital market diagram. This required a log function combined with an if-then statement (which is much simpler than what I devised the first time!). Add this in cell J6:

=IF((LOG(I6,0.956656)*-11.89327)>I6,I6,LOG(I6,0.956656)*-11.89327)

You should now have this:

	A	B	C	D	E	F	G	H	I	J
1	**Post Keynesian Business Cycle Simulation**								**$ values in billions**	
2								**Panic Gap =**	**$100.00**	
3			**K* =**	**$43,000.00**		**Kd =**	**$1,200.00**	**Panic Value =**	**$300.00**	
4		**Actual**	**Capital stock...............**		**Profit....**				**Investment Decision**	
5	**Time**	**I**	**K**	**K* - K**	**π**	**πe**	**π - πe**	**Pnc**	**K* - K - Pnc**	**ProdFunc**
6	1	$1,200.00	$40,000.00	$3,000.00	$1,200.00	$1,200.00	$0.00	$0.00	$3,000.00	$2,148.92

Aggregate investment was $1.2 trillion, the beginning stock of capital was $40 trillion, firms were $3 trillion short of their target, actual and expected profits were $1.2 trillion (and so panic was not triggered), and for next period firms wanted to close the gap between the target and actual stock of capital. With no panic, this meant $3 trillion. However, it will not be possible to build all that at once, and so cell J6 indicates that actual investment in period 2 will be right around $2.15 trillion.

Fair enough, but now we need subsequent periods. To do this, first block copy everything on row 6 and paste it into row 7. Now, however, we have to replace those initial values with formulas. That means deleting what you have in A7, B7, C7, and F7 and replacing them as follows (you won't need to do A7 if you downloaded my sample file above):

A7	B7	C7	F7
Time	I	K	πe
=A6+1	=J6	=C6-F3+B7	=E6

Again, with the logic...

A7: Easy enough: add one to the previous time period and you get the current one.

B7: J6 showed the level of investment firms decided to undertake back in period 1. Now that it's period 2, that level of investment occurs. Note that it will then create the profits shows under π. Think about that: whatever firms decided to invest in period t-1 creates their actual profits in period t (in aggregate, of course, not for each firm).

C7: The final stock of capital for period 2 will be what it was in 1, minus deprecation (Kd, which is a constant), plus whatever investment takes place over the period.

F7: Kalecki frequently cited Keynes' concept of convention when saying that, if agents have no specific reason to believe otherwise, they will assume that current conditions will continue. In other words, we expect in period t+1 for profits to be what they actually were in period t.

DONE! Now all you have to do is block copy row 7 and paste it for as many time periods as you like. Fifty are plenty to see what is going to happen (which will take you down to row 55). Now you have a complete simulation!

The next step is to get a plot. This is very easy. Select cells A6 to B55. Leaving them selected, click on the Insert tab and choose "Scatter" and then "Scatter with straight lines." What do you see? A business cycle (see below)!
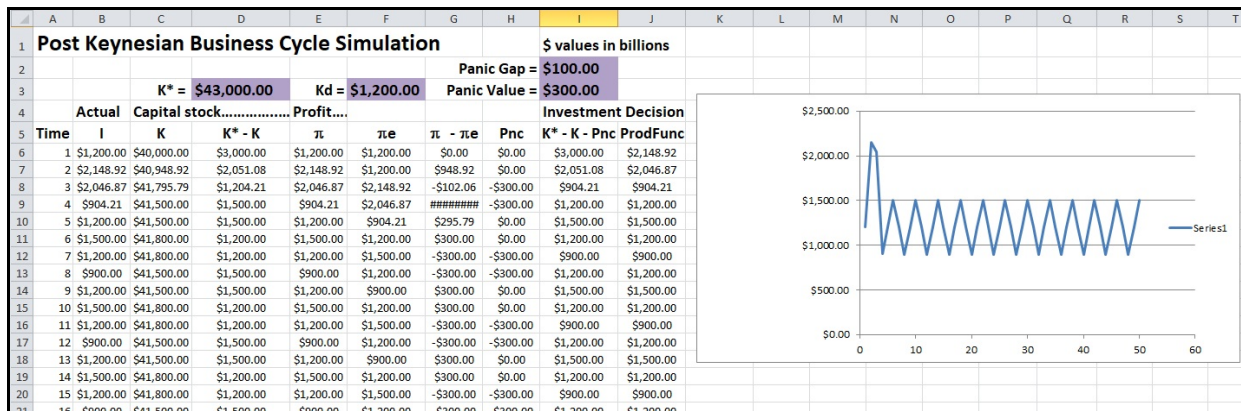
While his was obviously much more sophisticated, this is approach that Steve Keen used in his 1995 paper that built the model he used to predict the Financial Crisis.

The next question is, why does it have the particular shape that it does? Is it because of the structure of the model or the constants and initial conditions we selected? A bit of both, but that's for later. For now, sit back and marvel at your genius. You built a computer simulation of the economy!

WHEN YOU ARE DONE, PLEASE SEND YOUR EXCEL FILE TO ME!