# The Empirical Turnover Equation in Five Random Integer Simulations

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In this article we will demonstrate Green's empirical turnover equation[i] in five random integer simulations.

Let's start from Green's original dimensionless equation $I = \frac{GO}{GVA} + \frac{GO - GVA}{GVA}$, where GO is Gross Output and GVA is Gross Value Added.

If the actual number of turnovers is N per year, then $\frac{N}{I} \to {}^{1}\!/_{yr}$.

So we arrive at Green's empirical turnover equation:

$$N \simeq I \; {}^{1}\!/_{yr} \Rightarrow N \simeq \frac{GO}{GVA} + \frac{GO - GVA}{GVA} \cdot {}^{1}\!/_{yr} \quad (1)$$

In all five simulations we use random integers[ii] (values between 1 and 100) for the value added of each manufacturer and calculate *Total Value Added* and *Total Sales*. Total Value Added is GVA and Total Sales is GO. We consider the period of economic activity to be one year in all five cases.

**Simulation 1**

We consider an industrial sector comprised of 100 manufacturers in sequence, each one selling all his output to the next one, like in Green's original presentation with 4 producers. The results are:
GVA= 5246 and GO= 261902
Equation (1) gives $N \simeq 98{,}848$ per year
The actual number of turnovers is 100, and the deviation is less than 1,2%.

**Simulation 2**

We consider 13 industries, each comprised of 50 manufacturers, each producing a single commodity and each one selling all of its output to the next one. The results across all 13 industries are:
GVA= 32946 and GO= 234031
Equation (1) gives $N \simeq 13{,}207$ per year
The actual number of turnovers is 13, and the deviation is 1,59%.

**Simulation 3**

We consider 13 industries, this time each comprised of 200 manufacturers, each producing a single commodity and each one selling all of its output to the next one. The results across all 13 industries are:
GVA= 134025 and GO= 941443

Equation (1) gives $N \simeq 13{,}049$ per year

The actual number of turnovers is 13, and the deviation this time is 0,38%.

**Simulation 4**

We consider 13 industries, each comprised of 200 manufacturers, each producing a single commodity and each one selling all of its output to the next one, except industry *3* whose manufacturers sell half their output to industry *4* and the other half to industry *11*. Industry's *11* manufacturers use as inputs all of industry's *10* output and half of industry's *4*. We expect a fall in turnovers since half of industry's *4* output skipped seven industries.

The results across all 13 industries are:

GVA= 134025 and GO= 832099,5

Equation (1) gives $N \simeq 11{,}417$ per year

The actual number of turnovers is 11, and the deviation this time is 3,79%.

**Simulation 5**

We consider 13 industries, each producing a single commodity. Industries *1*, *2*, *3*, *11*, *12* and *13* are comprised of 50 manufacturers, while industries *4*, *5*, *6*, *7*, *8*, *9* and *10* are comprised of 100 manufacturers. Each manufacturer of an industry sells all of its output to a manufacturer belonging to the next industry, except industry's *3* manufacturers that sell half their output to each of industry's *4* manufacturers. Each of industry's *11* manufacturers buys the output of two manufacturers belonging to industry *10*.

The results across all 13 industries are:

GVA= 50044 and GO= 353132

Equation (1) gives $N \simeq 13{,}113$ per year

The actual number of turnovers is 13, and the deviation this time is 0,85%.

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[i] APPLYING THE TURNOVER FORMULA TO THE SYSTEM OF NATIONAL ACCOUNTS TO DETERMINE BOTH THE AMOUNT OF WORKING CAPITAL AND ITS ANNUAL RATE OF TURNOVER, Brian Green, 2017.

[ii] The random integers where produced using the generator from the site https://www.random.org/integers/