# Advanced$^2$ Economy Guide
# July, 2009

## Introduction

The Advanced Economy Guide was written to help novice players understand the Advanced Economy (AdEcon) to the point that they could play and enjoy the game.  It was *not* intended to provide enough details to satisfy more experienced players.  Therefore, this second guide was prepared to provide additional information about the AdEcon, so that players can immerse themselves in the system to better understand its complexities.

On the pages that follow, I present a few details about how resources are produced.  I will identify the specific game values used to determine production for each resource, and show where those values can be found.  Formulas that can be used to calculate the level of resources expected at any given slider level at any point in the game are provided.

To create each formula, I referred to three main resources for information.  The first was the Appendix to the Manual.  Most of the information is accurately portrayed there, but, it was also necessary to look at the AdEcon code.  WCS was very gracious in allowing me to see most of the relevant code, so that I could determine when the calculations occurred and in what order.  Several nuances were gleaned from the code that helped make sense of the system.  Finally, I conducted several dozen tests of the system to see if my assumptions proved to be correct.  I have found that the AdEcon is actually quite elegant, and remarkably simple.

The formulas I present are quite accurate, as far as they go.  There are simply too many extraneous variables that take or add a resource or two here and there for a single formula to account for everything.  I wanted to have formulas that are relatively easy to use, so these minor adjustments are simply not included.  They do not, however, make much difference in the basic calculations, except for waste.  Waste can cripple your production very quickly, but its estimation by formula is problematic, so I did not try to include it in the formulas I present.

## The Slider Settings

One of the most significant changes to the AdEcon is the behavior of the slider settings.  In COG, the settings were linear.  A full slider setting (75%) generated three times as much as a 25% slider setting, everything else being equal.

In COGEE there are base levels of labor allocations (slider settings) for each resource that are the point at which production is maximized.   Below that setting, production is decreased

proportionately.  Above that setting production is half of the amount that you would expect to add by the additional increment.  The manual, I believe, either misstates what happens below the base levels, or is somewhat misleading in describing the behavior.

Here are the base levels for each of the sliders:

Agricultural goods: 30%          Developments: 20%          Everything else 10%

At the base level, a certain amount of resources are produced.  So, let's assume that 12 Food are produced at a 30% setting in Agriculture.  As the slider is increased, this amount goes up as described above.  So, if you increase the slider to 60%, you'll only get 18 Food.  Why?  You'll get the 12 for the first 30%, but only 6 for the next 30%.  That's half the amount for the second 30% that you got for the first 30%.   Incremental production after the base level is halved.  That's how it works.

 **To build a formula that can be used to predict production of a resource, the effect of the slider has to be reduced to a single value, or multiplier.**   To construct the formulas, it was necessary to determine what all the likely multipliers would be for every base level, and each of several slider settings.  I chose to use increments of 5, for simplicity.

*Slider multiplier determination*:

On the chart to the right, notice that for a slider setting of the base level for any resource, the multiplier is always 1.

**For values below the base level**, the multiplier is the slider setting divided by the base level.

| Slider | Agriculture | Developments | Others |
|--------|-------------|--------------|--------|
| 5 | 0.166667 | 0.25 | 0.5 |
| 10 | 0.333333 | 0.5 | 1 |
| 15 | 0.5 | 0.75 | 1.25 |
| 20 | 0.666667 | 1 | 1.5 |
| 25 | 0.833333 | 1.125 | 1.75 |
| 30 | 1 | 1.25 | 2 |
| 35 | 1.083333 | 1.375 | 2.25 |
| 40 | 1.166667 | 1.5 | 2.5 |
| 45 | 1.25 | 1.625 | 2.75 |
| 50 | 1.333333 | 1.75 | 3 |
| 55 | 1.416667 | 1.875 | 3.25 |
| 60 | 1.5 | 2 | 3.5 |
| 65 | 1.583333 | 2.125 | 3.75 |
| 70 | 1.666667 | 2.25 | 4 |
| 75 | 1.75 | 2.375 | 4.25 |

For a setting that is one half the base level, the multiplier is .5.

**For slider values above the base level**, the multiplier is based on the amount the slider setting is over the base level.  So, for Labor (an Other), if the setting is 40, that is 30 over the base level. Call this "Overage."  You will only get half of the overage to simulate inefficiencies in production.  So, using the Labor example above, if the overage is 30, this becomes 15.  Now, 15 is one and a half times 10, but you still get the resources the first 10 slider points produce, so

you actually get two and a half times the production you would get at 10.  That is why the table shows 2.5 as the multiplier.

For you math types, here are the formulas that I used to calculate the multipliers –

At or below the base level: $$\frac{Slider\ Setting}{Base\ Level}$$

Above the base level: $$1 + \frac{Slider\ Setting - Base\ Level}{Base\ Level \times 2}$$

## Formula Accuracy

To make sure that the formulas were correct, I tested them by comparing the results of the formulas for each province to the amount that is shown on the Development Advisor screen (DA).  This was done province by province with national sums calculated for each playable country.

The differences between these sums of the formula calculations and the sums of what the (DA) predicts for each country can be seen in the table below.  Notice that for all countries except Russia and Turkey, the differences are very small.  In fact, almost all of them are 0.  Since Russia and Turkey have waste levels of 40% and 14%, respectively, there should be significant differences between the calculated amounts and the DA amounts.  Because the effects of the levy level is not shown in the provincial figures (i.e., the top boxes), the large differences for Russia and Turkey must be related to Waste.

**Differences in Formula Calculations vs Development Advisor Screen Amounts**

| | Money | Labor | Wood | Iron | Wool | Cotton | Horses | Food | Wine | Spice | Luxuries | Textiles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | -1 | 0 | 0 | 0 |
| Britain | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3 | 0 | 0 | 0 | 0 |
| Sweden | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 |
| Prussia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Austria | 0 | 0 | 0 | 2 | -1 | 0 | 0 | -3 | 0 | 3 | 2 | 0 |
| Russia | -160 | -15 | -91 | -84 | -191 | 0 | -45 | -341 | -39 | -80 | -83 | 0 |
| Turkey | -43 | -6 | -33 | -37 | -40 | -17 | -10 | -58 | -9 | -36 | -35 | -4 |
| Spain | 0 | 0 | 0 | -1 | -1 | 0 | 0 | 0 | 0 | -1 | 0 | 0 |

To determine the overall accuracy of the formulas, including waste, the formula calculations were then reduced by the nominal amounts of the waste that Russia and Turkey are experiencing in the test scenario, to compare those figures against the DA amounts.

For example, Sweden has a -10% for Wine (see the table below). This means that the DA shows 10% less than the formula. But, there is only a one Wine difference (see the table above), so this is not really important. Notice that the DA predicts that Russia will receive 26% less Horses than the formula amount. Remember, this is *after* the expected waste amounts have been subtracted from the formula amounts, so this is loss far and above the estimated effects of waste. The discrepancy cannot be explained using my methodology, but the waste calculations are very complicated and certainly don't reflect the simple use of the nominal amounts. I have no idea why the differences are so large. In any case, to avoid waste, build courts up to level 5 in as many provinces as possible. Once that's been done, my formulas will work accurately once more.

**Percentage of Difference to Formula after subtracting Nominal Waste from formula results**

|  | Money | Labor | Wood | Iron | Wool | Cotton | Horses | Food | Wine | Spice | Luxuries | Textiles |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| France | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -2.4% | 0.0% | -1.9% | 0.0% | 0.0% | 0.0% |
| Britain | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -1.5% | 0.0% | 0.0% | 0.0% | 0.0% |
| Sweden | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -10.0% | 0.0% | 0.0% | 0.0% |
| Prussia | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Austria | 0.0% | 0.0% | 0.0% | 1.7% | -0.8% | 0.0% | 0.0% | -1.3% | 0.0% | 2.7% | 1.5% | 0.0% |
| Russia | -6.2% | 22.6% | -9.5% | -4.4% | -12.3% | 0.0% | -26.2% | -4.3% | -14.2% | -6.0% | -3.7% | 40.0% |
| Turkey | -12.1% | 2.9% | -12.2% | -21.9% | -11.8% | -6.0% | -21.7% | -5.8% | -18.1% | -6.9% | -10.6% | 9.4% |
| Spain | 0.0% | 0.0% | 0.0% | -1.6% | -1.3% | 0.0% | 0.0% | 0.0% | 0.0% | -1.3% | 0.0% | 0.0% |

The effect of the Feudal Level on resource production has been excluded from the formulas, because it seems that these adjustments are not applied to the individual provinces, but to the total production for the nation.

Also, keep in mind that there are extraneous variables that change actual production amounts that are not present at this scenario's beginning, so they are not included in the formulas or the verification spreadsheets. The effects of weather, the presence of enemy units, resource altering game events, etc., are not considered. The manual details each of these.

## The Production Formulas

There are seven values that appear in the formulas for the resources.  Most require the first five only.  They are:

1. The current propensity for the province to produce that resource (Base Amount or **BA**). Keep in mind that **zero (0) values in these columns are interpreted by the code to be .5, except for Cotton.**  That is why the multiplicative nature of the formulas still work; no single value that is multiplied with the others will ever be zero, thus providing some production for each of the resources, if there is any slider setting above zero, except Cotton.  If Cotton is zero in this file, no Cotton can ever be produced in the province. Also, some of the other values used in the formulas may be so small that the amounts produced may still be zero.

   The BA are found in *COG2Provinces.txt* in the columns as indicated by the table below.

   | Resource | Column |
   |----------|-----------|
   | Horses | HorseProd |
   | Food | Food |
   | Iron | Iron |
   | Wood | Timber |
   | Wool | Wool |
   | Wine | Wine |
   | Cotton | Cotton |
   | Spice | Spice |
   | Luxuries | Luxuries |
   | Textiles | Textiles |

   Notice that some of the values in the formulas change during game play.  So, while there may be four Factories in a province at the beginning of a scenario, more can be built.  The actual number of completed factories is always used in the formula.

2. The current number of each Development.   These are always found in *COG2Start.txt* for newly started games.  On the Development Advisor screen for games in progress).  **Only Farms, Factories, and Banks aid in production.**  Also remember that these values change during game play, so be sure to use the current values in your calculations.

3. The Slider Multiplier, or "Slider Value" in the formula.  This increases or decreases the production based on the slider setting as dictated by the base amount for the resource. **See the explanation above to see how this value is determined.  Also note that Textiles uses the actual slider setting, not the multiplier**

4.  The Current National Morale level.  This is the "Morale" value from *COG2Players.txt,* less 1,000, for newly started games, otherwise use the amount from the Economic Advisor screen.

5.  The current Tax Rate.  This is the "TaxRate" value from *COG2Players.txt* for newly started games.  Otherwise it's the amount found on the Economic Advisor.)

6.  The Current Population.  This is the amount found on the Development Advisor Screen for each province.

7.  The Base Amount of Money the province generates.  This can be found in COG2Provinces.txt in the "Money" Column.

Remember that the Textile slider produces only **capacity** to convert Wool and Cotton.  It does not produce any Textiles, *per se*.  The general formulas for all resources except Textiles conversion can be found on the following Page.  Because Textiles have a unique conversion process, they can be found on the section titled *Textile Conversion*.

Also remember that the results of all calculations are rounded down once the final figure has been calculated.

## Formula Summary for Non-Monetary Tradable Resources except Textiles

| Resource | Base Amount from *COG2Provinces.txt* (Column Name) | × | $1 + \dfrac{Development}{10}$ | × | $1 + \dfrac{National\ Morale}{10,000}$ | × | Slider Value | × | $\left(1 - \dfrac{Tax\ Rate - 15}{100}\right)$ |
|---|---|---|---|---|---|---|---|---|---|
| Wood | Timber | | Farms | | | | | | |
| Iron | Iron | | Factories | | | | 4.25 | | |
| Wool | Wool | | Farms | | | | | | |
| Cotton | Cotton | | Farms | | Economic Advisor or *GOG2Start.txt* | | | | Economic Advisor or *GOG2Start.txt* |
| Horses | HorseProd | | Farms | | | | | | |
| Food | Food | | Farms | | | | 1.75 | | |
| Wine | Wine | | Farms | | | | | | |
| Spice | Spice | | Farms | | | | 4.25 | | |
| Luxuries | Luxuries | | Factories | | | | | | |

## Formula Summary for Labor

| Resource | $\dfrac{Population}{10}$ | × | $1 + \dfrac{Development}{2}$ | × | $1 + \dfrac{National\ Morale}{10,000}$ | × | Slider Value | You always get at least one labor. |
|---|---|---|---|---|---|---|---|---|
| Labor | MaxPop from *COG2Start.txt* (or Current Population) | | Factories | | Economic Advisor or *GOG2Start.txt* | | 4.25 | |

## Summary for Textile Capacity  . You do not use the slider multiplier for the formula

| Resource | Base Amount from *COG2Provinces.txt* (Column Name) | × | $1 + \dfrac{Development}{4}$ | × | $\dfrac{Slider\ Setting}{100}$ | × | Amount from *COG2Start.txt* (or Current Population) |
|---|---|---|---|---|---|---|---|
| Textile | Textiles | | Factories | | The slider **setting** is divided by 100 | | MaxPop |

## Formula Summary for Money

| Resource | Amount from *COG2Provinces.txt* (Column Name) | × | $1 + \dfrac{Development}{10}$ | × | $1 + \dfrac{National\ Morale}{10,000}$ | × | $\left(\dfrac{Tax\ Rate}{15}\right)$ |
|---|---|---|---|---|---|---|---|
| Money | Money | | Banks | | Economic Advisor or *GOG2Start.txt* | | Economic Advisor or *GOG2Start.txt* |

## Examples from the 1805 Standard Scenario.

All of these examples are for the initial turn with slider settings of 75.

| Resource | Province | Example | Formula Result | DA Amount |
|---|---|---|---|---|
| Money | Flanders | $25 \times \left(1 + \frac{2}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times \frac{20}{15}$ | 42.00 | 42 |
| Labor | Flanders | $\left(\frac{8}{10}\right) \times \left(1 + \frac{2}{2}\right) \times \left(1 + \frac{500}{10000}\right) \times 4.25$ | 7.14 | 7 |
| Wood | Berri | $2 \times \left(1 + \frac{2}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times 4.25 \times \left(1 - \frac{20 - 15}{100}\right)$ | 10.17 | 10 |
| Iron | Gascony | $2 \times \left(1 + \frac{2}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times 4.25 \times \left(1 - \frac{20 - 15}{100}\right)$ | 10.17 | 10 |
| Wool | Flanders | $2 \times \left(1 + \frac{3}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times 4.25 \times \left(1 - \frac{20 - 15}{100}\right)$ | 11.02 | 11 |
| Cotton | Valencia | $2 \times \left(1 + \frac{2}{10}\right) \times \left(1 + \frac{0}{10000}\right) \times 4.25 \times \left(1 - \frac{15 - 15}{100}\right)$ | 10.2 | 10 |
| Horses | Berri | $3 \times \left(1 + \frac{2}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times 1.75 \times \left(1 - \frac{20 - 15}{100}\right)$ | 6.28 | 6 |
| Food | Flanders | $9 \times \left(1 + \frac{3}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times 1.75 \times \left(1 - \frac{20 - 15}{100}\right)$ | 20.42 | 20 |
| Wine | Languedoc | $4 \times \left(1 + \frac{1}{10}\right) \times \left(1 + \frac{500}{10000}\right) \times 1.75 \times \left(1 - \frac{20 - 15}{100}\right)$ | 6.70 | 6 |
| Spice | Moscow | $3 \times \left(1 + \frac{3}{10}\right) \times \left(1 + \frac{0}{10000}\right) \times 4.25 \times \left(1 - \frac{15 - 15}{100}\right)$ | 16.58 | 16 |
| Luxuries | Belfast | $3 \times \left(1 + \frac{4}{10}\right) \times \left(1 + \frac{0}{10000}\right) \times 4.25 \times \left(1 - \frac{15 - 15}{100}\right)$ | 17.85 | 17 |

| Resource | Province | Example | Formula Result | DA Amount |
|---|---|---|---|---|
| Textiles (Capacity) | Anglia | $2 \times \left(1 + \frac{3}{4}\right) \times .75 \times 8$ | 21.00 | 21 |

Notes:  Examples were chosen that had relatively large yields of resources.  The formulas work equally well with smaller values.

In all cases, **final** amounts are rounded down.  I do not detect any other rounding in the variables, at least as they affect these formulas.  There is, however, other rounding in the economic model.