

Professional development workshop

Research workflow: <https://github.com/irudik/dyson-workflow>

Ivan Rudik

What is workflow?

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The goal is to optimize the combination of things you care about:

- Efficiency
- Total research production
- Enjoyability
- Mental expenditures
- Research quality
- Having the process be easy and foolproof

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"You need to protect yourself from previous you." -Alex Hollingsworth

Why does it matter?

Research is a marathon

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Paper	Initial Work	Submitting	R&R	Accepted	Published	Total Time (Years)	Time to Submit (Years)
Climate Inertia	Feb-2012	Jun-2014	Dec-2015	Apr-2017	Oct-2017	5.67	2.33
RPS Theory	Feb-2013	Jan-2016	Dec-2017	Feb-2018	Jun-2018	5.33	2.92
RPS Empirics	Feb-2013	Nov-2015	Jan-2017	Feb-2018	Jan-2019	5.92	2.75
Climate Damage Risk	Feb-2014	Jan-2016	Apr-2017	Aug-2019	May-2020	6.25	1.92
Gas Flaring	Dec-2015	Dec-2017	Dec-2019	Apr-2020	Jul-2020	4.59	2
Parks Air Pollution	Jan-2016	Jan-2018	Apr-2018	Jun-2018	Jul-2018	2.5	2
Lead Mortality	Jan-2018	Jul-2019	Dec-2019	Jun-2020	Aug-2021	3.58	1.5
Lead Test Scores	Jan-2018	Dec-2020					2.92
Climate Adaptation	Sep-2018						
Birds and Pollution	Jan-2019	Jun-2020	Jul-2020	Oct-2020	Dec-2020	1.92	1.42
Valuing Forecasts	Jan-2019						
Growth and Biodiversity	Apr-2020						
Geography of Regulation	Apr-2020						
Social Cost of Carbon	Sep-2020						
Climate Networks	Jun-2021						

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Previous slide shows I have **seven** projects going right now (probably 2 are getting attention in any given week)

- 3 working papers
- 2 late stage projects
- 2 early stage projects

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Good workflow is a way to manage this work and get stuff done in a sustainable and efficient way

Caveats and qualifications

What I'm going to tell you about is what **I** think is important and how **I** do stuff

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Good sources: EconTwitter, Hidden Curriculum Podcast, Shapiro and Gentzkow notes, Grant McDermott, Alex Hollingsworth, Patrick Baylis, Stack Exchange

(Some) key components

- Programming
- Version control
- Code/data management and project organization
- Time management

Programming

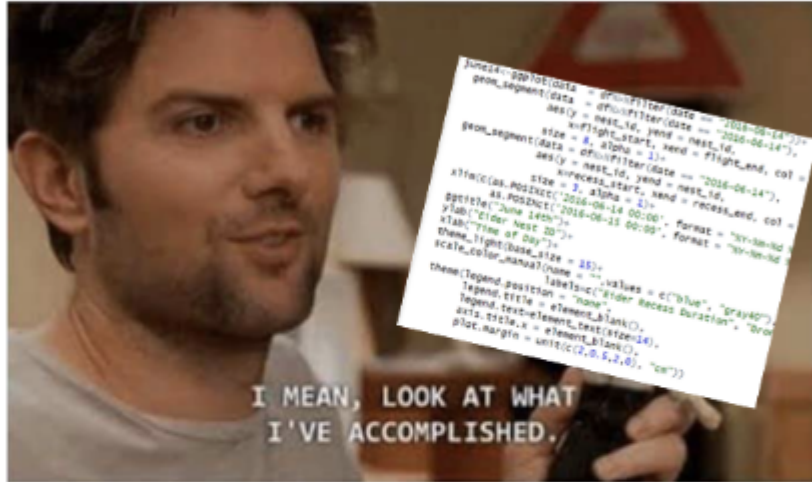
Programming is srs business



Andrew Barnas
@AndrewBarnas



Spending too long on R code and then trying to explain to someone just how much work went into it



1,119 11:31 AM - Aug 25, 2021



Jodi Beggs ✓
@jodiecongirl



R vs. Stata [twitter.com/obrienjohnjack...](https://twitter.com/obrienjohnjack)

Ian Fleming's Jack O'Brien @obrienjohnjack

a movie studio gives you \$100 million to write and direct your first movie. BUT you are contractually obligated for it to be a "versus" movie. what two characters do you match up?

77 2:01 PM - Nov 30, 2020



[See Jodi Beggs's other Tweets](#)



Programming is srs business

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- The field you work in
- How much you care about co-authoring
- How much you're into open science and reproducibility

Programming is srs business

Conventional choices for economists: Stata and MATLAB

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MATLAB's package ecosystem is bad but it has first-mover advantage

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Both are open source: free, but generally things aren't quite as polished

Programming is srs business

Major tradeoffs:

R/Julia have a smaller userbase in econ, by a lot

- Every AEJ: App paper last year had Stata code
- Rudik (2020) is the second(?) AEA journal paper using Julia

But the R/Julia share of economists working on cutting-edge stuff with big data, ML, quant models is larger (e.g. Grant McDermott, Jonathan Dingel, Milena Almagro, Alex Hollingsworth, Ariel Ortiz-Bobea, me)

These network externalities matter

Programming is srs business

Trade off of your actual time vs computer time

Some large-scale problems are unsolvable with Stata/MATLAB, you might need to learn another language anyway

Version control

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Research is a highly non-linear process: you inevitably will need to go back to previous versions of your project to undo changes, fix new errors you can't figure out, etc

There's **many** different methods to versioning, all have different levels of fixed and variable costs you need to incur to use them

Choose your level of control

Local hard
disk



Dropbox



Dropbox +
date naming



Git +
Github



Versioning level 1

One way to do version control is to just keep different versions of files on your local hard drive: `file-03-01-2021`, `file-03-02-2021`, `file-final_FINAL2`, `file-myname`, `file-myname-yourname`

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Seriously, don't

Versioning level 2

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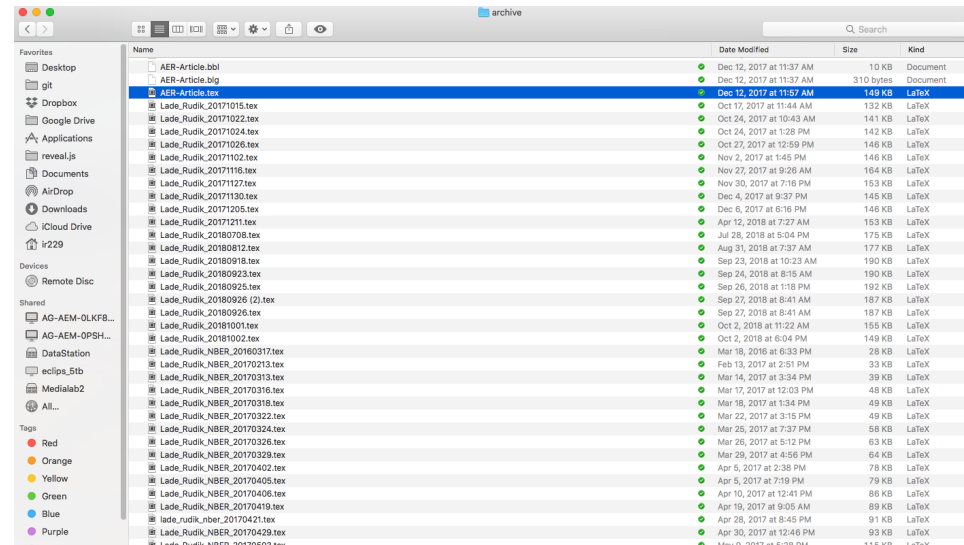
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If you pay for the fancier versions you can also rewind to previous versions up to X days ago

Versioning level 3

A third way to do this is to combine 1 and 2: use a cloud provider but then use some sort of file naming system to keep track of different versions



The problem is then you have lots of files, little understanding of changes made between versions

Versioning level 4

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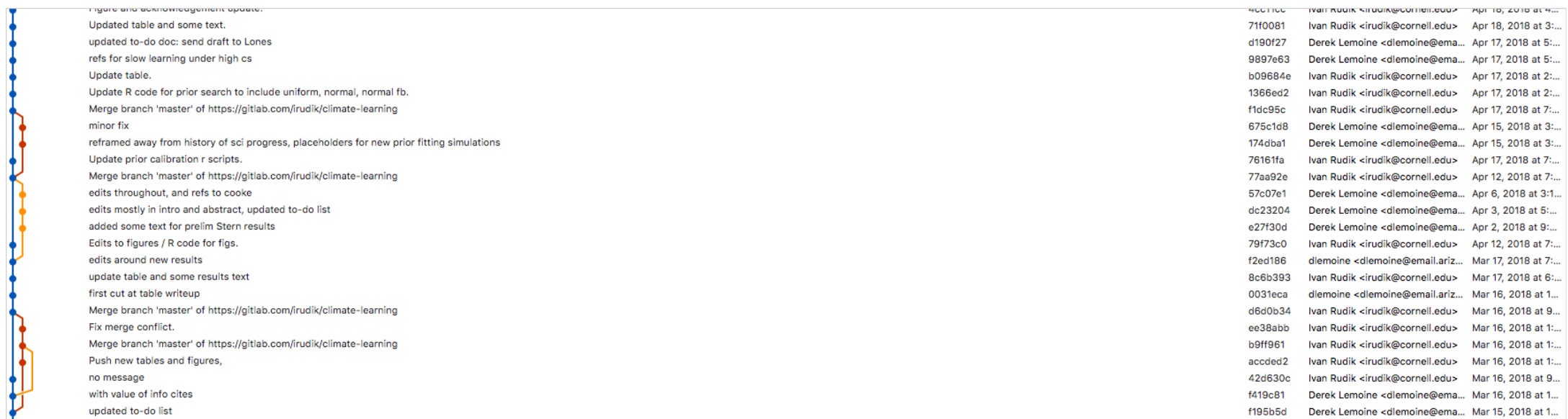
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Git keeps track of changes of your files and stores these changes in a history along with messages, tags, author identifiers, etc

This makes it very easy to find who made changes and when and to see exactly what changes were made

Versioning level 4: Git

Quick example of one of the programs (SourceTree) you can use to implement Git/GitHub workflow:



Versioning level 4: Git

Quick example of a GitHub repo:

The screenshot shows a GitHub repository page for 'climate-trade' by user 'irudik'. The repository is private and has 15 issues, 4 branches, and 2 tags. The main content area displays a list of files and folders, including 'CDP_codes_four_sectors', 'archive', 'counterfactual', 'counterfactual_cdp', 'latex_extras', 'references', '.gitignore', and several R scripts. The right sidebar contains sections for 'About' (Microfoundations for aggregate climate damages), 'Releases' (2 tags), 'Packages' (No packages published), and 'Contributors' (3 contributors: irudik, weiliangt, and another user).

irudik / climate-trade Private

Watch 2 Star 0

Code Issues 15 Pull requests Actions Projects Wiki Security Insights Settings

master 4 branches 2 tags

Go to file Add file Code

About

Microfoundations for aggregate climate damages.

Releases

2 tags

Create a new release

Packages

No packages published

Publish your first package

Contributors 3

irudik Ivan Rudik

weiliangt Weiliang Tan

File/Folder	Commit Message	Time Ago
CDP_codes_four_sectors	Merge branch 'master' into overleaf-2021-01-15-1813	8 months ago
archive	update file names	last month
counterfactual	fix single shock	26 days ago
counterfactual_cdp	Something with the data? not xbilat.	8 months ago
latex_extras	Updates from Overleaf	8 months ago
references	Updates from Overleaf	8 months ago
.gitignore	Update gitignore with renv.	6 months ago
0.00_initialize_cf_data.R	update file names	last month
1.00_download_weather_data.R	update file names	last month
1.01_global_map.R	update file names	last month
1.02_weather_aggregation_weights.R	update file names	last month
1.03_weather_aggregation_data.R	update file names	last month

Code/data management and project organization

Data/code management

How does data/code organization improve workflow?

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Less stuff you need to keep in your brain

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If everything is the same, then working with your projects becomes largely automatic, no trying to remember where certain types of data are located, how you organize your coding scripts in run-order, etc

Data/code management

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If everything is the same, then working with your projects becomes largely automatic, no trying to remember where certain types of data are located, how you organize your coding scripts in run-order, etc

Makes life easier to use best practices like relative file paths, `here :: here`, etc

One way to organize data and code

- Parent folder
 - Code folder
 - Data cleaning code
 - Analysis code
 - Data folder
 - Raw data
 - Clean data
 - Output folder
 - LaTeX folder

Code script organization

A project will likely have multiple files for data cleaning/analysis

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When working with other people (or your future self), it's smart to order your files:

- 01.first-file-to-run
- 02.second-file-to-run
- ...
- 000.project-functions
- 000.RUN-ALL-SCRIPTS.sh

Centralize and optimize your environments

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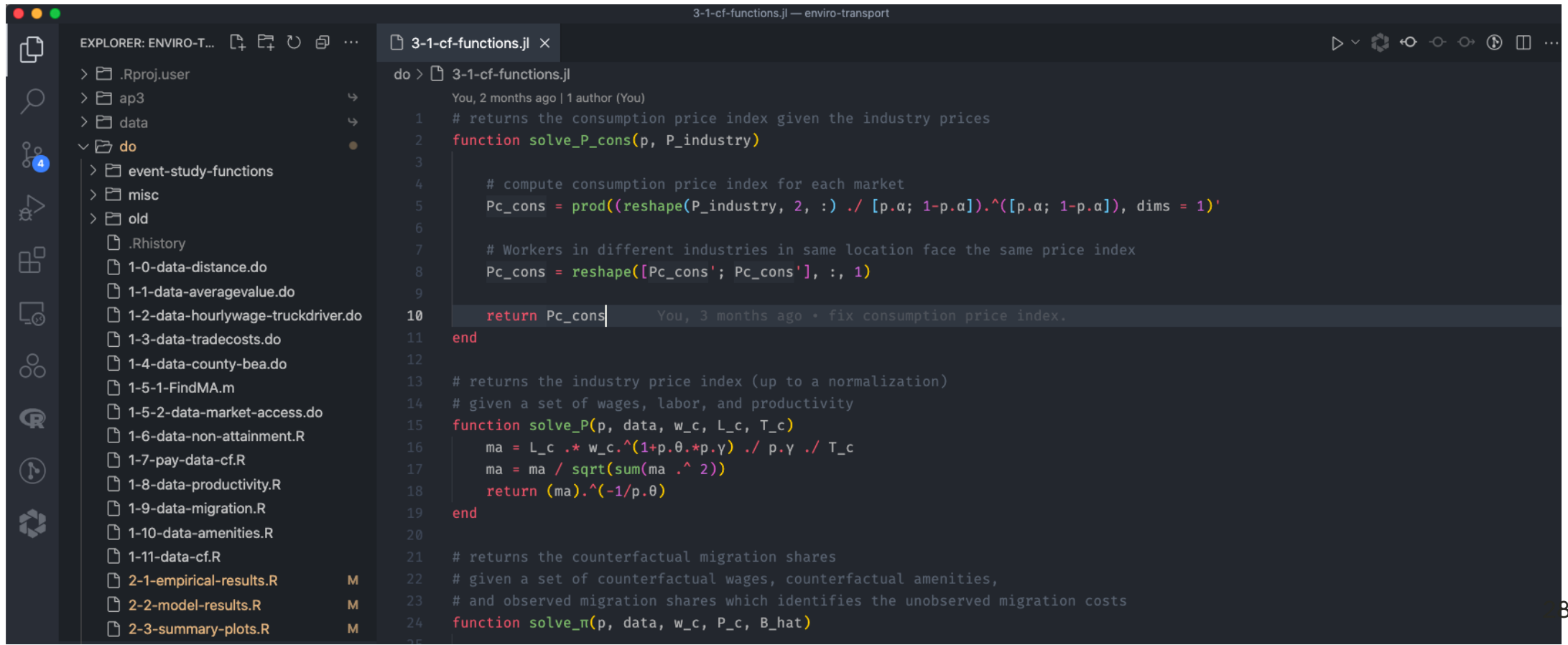
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Having a single coding environment that is easy to modify and adapt will make you much more efficient at your job

There's a lot of options (Atom, emacs, Vim, Sublime Text) but I'll tell you about **Visual Studio Code**

Centralize and optimize your environments: VSCode

Visual Studio Code (VSCode) is probably the most widely used development environment



```
3-1-cf-functions.jl — enviro-transport

EXPLORER: ENVIRO-T...
> .Rproj.user
> ap3
> data
> do
  > event-study-functions
  > misc
  > old
    .Rhistory
    1-0-data-distance.do
    1-1-data-averagevalue.do
    1-2-data-hourlywage-truckdriver.do
    1-3-data-tradecosts.do
    1-4-data-county-bea.do
    1-5-1-FindMA.m
    1-5-2-data-market-access.do
    1-6-data-non-attainment.R
    1-7-pay-data-cf.R
    1-8-data-productivity.R
    1-9-data-migration.R
    1-10-data-amenities.R
    1-11-data-cf.R
    2-1-empirical-results.R M
    2-2-model-results.R M
    2-3-summary-plots.R M

do > 3-1-cf-functions.jl
You, 2 months ago | 1 author (You)
1 # returns the consumption price index given the industry prices
2 function solve_P_cons(p, P_industry)
3
4     # compute consumption price index for each market
5     Pc_cons = prod((reshape(P_industry, 2, :) ./ [p.a; 1-p.a]).^([p.a; 1-p.a]), dims = 1)'
6
7     # Workers in different industries in same location face the same price index
8     Pc_cons = reshape([Pc_cons'; Pc_cons'], :, 1)
9
10    return Pc_cons
11 end
12
13 # returns the industry price index (up to a normalization)
14 # given a set of wages, labor, and productivity
15 function solve_P(p, data, w_c, L_c, T_c)
16     ma = L_c .* w_c.^(1+p.θ.*p.γ) ./ p.γ ./ T_c
17     ma = ma / sqrt(sum(ma.^2))
18     return (ma).^(-1/p.θ)
19 end
20
21 # returns the counterfactual migration shares
22 # given a set of counterfactual wages, counterfactual amenities,
23 # and observed migration shares which identifies the unobserved migration costs
24 function solve_π(p, data, w_c, P_c, B_hat)
```

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How does using VSCode (or Atom/Sublime/etc) improve workflow?

1. The environment is the same no matter whether I'm writing in
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4. Fully integrated with Git
5. Lots of useful and customizable hot keys for mass editing

Tasks and communication

Organizing tasks and project communication is important for actually getting things done

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There are **many** ways to do this

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Here's a few suggestions:

1. **GitHub Issues**
2. **Slack**
3. Other task management providers: **Asana**, **Wrike**, etc (possibly with Slack)

Tasks and communication

If you're a Git user I recommend using **GitHub Issues**:

1. Everything's on GitHub
2. Commits/pull requests etc can be referenced in task-specific issues so changes are easy to find
3. GitHub has a Projects feature that is similar to Asana/Wrike

Writing

If you've got co-authors I recommend [Overleaf](#)

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Solo projects: probably use Dropbox or Git+GitHub

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The key idea is that the framework for your code, writing, etc should all be the same and easy to implement

Meta-reproducibility

Spinning up a new project with people should be **easy** (besides the research part)

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Easy way to set up the initial framework:

- Create a GitHub template repo
 - <https://github.com/cornell-seere/repo-template>
- Create a GitHub repo for your Dropbox folder for non-versioned files
 - <https://github.com/cornell-seere/dropbox-template>

If you do this you can spin up a full, clean project in ~1 minute

Cross-project reproducibility

You're going to use the same functions a lot of the time across projects, e.g.
here's my base plotting template:

```
main_theme ←  
  theme_minimal() +  
  theme(  
    legend.position = "none",  
    title = element_text(size = 24),  
    axis.text.x = element_text(size = 24), axis.text.y = element_text(size = 24),  
    axis.title.x = element_text(size = 24), axis.title.y = element_text(size = 24),  
    panel.grid.minor.x = element_blank(), panel.grid.major.y = element_blank(),  
    panel.grid.minor.y = element_blank(), panel.grid.major.x = element_blank(),  
    panel.background = element_rect(fill = "#ffffff", colour = NA),  
    plot.background = element_rect(fill = "#ffffff", colour = NA),  
    axis.line = element_line(colour = "black")  
  )
```

Time management and organization

**“Work expands so as to fill the
time available for its completion”**

Parkinson's Law

Time management

DO WHAT YOU LOVE
AND YOU'LL ~~NEVER~~
~~WORK A DAY IN YOUR~~
~~LIFE~~ WORK SUPER
FUCKING HARD ALL
THE TIME WITH NO
SEPARATION OR ANY
BOUNDARIES AND ALSO
TAKE EVERYTHING
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@ADAMJK

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I schedule no meetings or obligations in the morning because that's when I like to do research

Second-order thing for me: I typically have some task in mind that I want to complete in the next 2-3 hours (e.g. get half my presentation slides done, finishing writing the code to aggregate the CPS to state-level, etc)

Time management

There's a lot of fancy books and stuff on this

First-order thing that matters (imo): work when you're most productive

I schedule no meetings or obligations in the morning because that's when I like to do research

Second-order thing for me: I typically have some task in mind that I want to complete in the next 2-3 hours (e.g. get half my presentation slides done, finishing writing the code to aggregate the CPS to state-level, etc)

Anyone who tells you they actually do 40+ hours of research a week is lying to you