PAGE
policy analysis on growth and employment

Gender and Age Diversity to Forster Innovation and Productivity Growth

RESEARCH PROPOSAL

Presented to

Partnership for Economic Policy (PEP)

By

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Before you begin

Please make sure to carefully review and understand the following

- ➢ [Webpage](#) – especially with regards to the PAGE priority themes and
- ➢ [Guidelines](#) – for designing a research project proposal (in scientific terms)
- ➢ [PEP requirements and strategy](#) for policy engagement and research communication

Please note that :

- – This template is mandatory for proposals of projects submitted under the [PMMA](#) and [MPIA](#) groups, i.e. that do not involve data collection
- – Plagiarism is strictly forbidden – see note on "references and plagiarism" at the end of this document/template. PEP will be using a software program to detect cases of plagiarism.
- – PEP encourages applicant research teams to submit proposals in English, but content (in text boxes below) may also be written in French or Spanish (and will be accepted given proper justification of language barrier).

There are three main areas/dimensions to all PEP-supported projects: capacity building, research and policy engagement. Each dimension must be considered with due care and attention, as they will be assessed individually and concurrently to determine the overall quality of a proposal.

The PEP proposal template is structured in five sections, as follows:

- - Project overview and objectives
- - Capacity building – team composition and experience
- - Research – literature review, method and data
- - Policy relevance and engagement strategy
- - Other considerations

SECTION I – PROJECT OVERVIEW & OBJECTIVES

1.1. Abstract (max 100 to 250 words)

The abstract should state the main research question, the context and its relevance in terms of policy issues/needs in relation to PAGE priority issues. Complete with a brief description of the method and data that will be used.

Women participation in the labor market is an upward trend and high unemployment rates of young workers is a fact. Although many aspects have been investigated in the economic literature related to these issues, there are still avenues under explored. One part of the literature that has not been investigated extensively is whether worker's diversity is an asset for innovation activities. The scant literature suggest that gender diversity may play a role on innovation, but age diversity does not present any impact. However, these evidences are based mainly on cross-section datasets and consider these worker's characteristics as isolated facts, in other words, not related to worker's educational level. By using a firm-level panel structure of the Brazilian innovation survey jointly with other sources, our research proposal aims to contribute to this literature by investigating how worker's diversity considering their educational level may play an important role for innovation, productivity growth and eventually economic development.

1.2. Main research questions and contributions (max 500 to 700 words)

Explain the focus (or key questions) of your research and its policy relevance. Explain why you think this is an interesting research question and what the potential usefulness and value added of your work might be - in terms of both (general) knowledge gaps and policy needs for evidence base.

The literature review shall be detailed under "Research" (section III), not in this section.

Long term economic growth can be explained by a diverse range of factors, but there is a crucial one among all of them: productivity growth. Notwithstanding, productivity has always been a relevant topic among economists and policymakers. Interest is understandable since productivity is the main factor for long term economic growth. Krugman (1994) coined an expression which shows its importance: "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker. … Compared with the problem of slow productivity growth, all our other long- term economic concerns - foreign competition, the industrial base, lagging technology, deteriorating infrastructure and so on - are minor issues." Based on this acknowledgment, economists try to understand the determinants of productivity and their effectiveness.

One part of the literature on understanding economic growth has investigated whether countries were able to promote an structural change in their economies, see O'Leary and Webber (2015) and McMillan and Rodrick (2011). According to these two papers, economic

activity moving towards most productive sector was the main driver for economic growth in Europe and Asia, but not in Latin America as observed in McMillan and Rodrick (2011). Generally, Latin American countries experienced similar productivity growth within sectors compared to Asian countries, but they were not able to move employment towards more productive sectors (structural change), see McMillan and Rodrick (2011) for further analysis. Focusing only in Brazilian manufacturing sector, recent research provides evidence that the main problem with the slow productivity growth from 2000 until 2013 is due to a decrease in the within industry component, see Lage de Sousa and Moreira (2017). Although, Latin America productivity growth might be explained for the lack of structural change in the 80's and 90's, it seems that Brazilian stagnated productivity growth has changed to within industry in this millennium. Therefore, understanding how productivity might be enhanced at firm level, which is the main part of within industry productivity growth, remains a relevant topic. One of the main drivers of productivity growth is innovation, as evidenced by Syverson (2011) and how to foster innovation is crucial for productivity growth, eventually economic development.

Our research focus in on whether worker's diversity may work as an important catalyzer for innovation and consequently productivity growth. To the best of our knowledge, we are not aware of any research investigating how gender and age diversity impacts innovation using a panel of firms in the literature, neither in developing countries nor in developed world. Therefore, we believe that our research may provide a contribution to the literature by investigating this issue carefully with a rich dataset.

Our main research questions are:

1. Does worker's diversity in terms of age and gender enable firms to become more innovative, especially considering workers educational level?
2. What type of innovation is more influenced by worker's diversity: product, process or organization innovation?
3. If diversity is relevant for innovation, does innovation enable firms to become more productive considering their worker's diversity?
4. If firms become more productive due to their innovation activities, did it translate into a structural change in the economy?

SECTION II – CAPACITY BUILDING

2.1. Team composition and experience

For each research team member, please indicate (using the following tables – one per member):

1. **Age, sex, as well as relevant/prior training and experience** in the issues and research techniques involved (start with team/project leader).

    - Note that PEP favors gender-mixed teams, composed of a maximum of four (4) members, at least 50% female researchers, and at least two (2) junior researchers (aged under 30), all contributing substantively to the research project. PEP also seeks gender balance in team leaders and thus positively encourages female-led research teams.

    - Each listed member must post an up-to-date CV in their profile on the PEP website – refer to "How to submit a proposal" on the call's [webpage](#).

2. **Benchmark and expected capacity building**:

    – Describe the research capacities that each team member (and potentially her/his affiliated institutions) is expected to build through their participation in this project. This is an important aspect in the evaluation of proposals and should be presented in detail.

        • What techniques, literature, theories, tools, etc. will each team member and her/his institutions learn (acquire in practice) or deepen her/his knowledge of?

        • How will these skills help each team member in their career development?

        • What are the current state of knowledge of each team member in regard to the project you are proposing?

3. **Task and contributions to project**: Indicate the specific tasks each team member would carry out in executing the project.

    – Note that one of the team members must be clearly identified as responsible for coordinating and reporting on the design/implementation of the projects' policy engagement and communication strategy (see section III below). To achieve a more balanced task distribution, PEP advises to select a member other than the project leader.

Team leader

Name	Age	Sex (M, F)	Highest degree/diploma
Filipe Lage de Sousa	43	M	Doctor of Philosophy (PhD)
Training and experience	Provided consultancy to numerous multilateral institutions, such as the World Bank, IADB, UNESCAP, JICA, GDN and others		
Expected capacity building	Lecturer of micro econometrics, specialized in panel data, in a Brazilian university.		
Contribution to project	- Defining the methodology to be implemented - Working on the research as a team member by implementing the empirical strategy and writing the paper - Responsible for dissemination		

Team member #2

Name	Age	Sex (M, F)	Highest degree/diploma
Glaucia Estefânia de Sousa Ferreira	34	F	Master Degree
Training and experience	Experience working in different projects leaded by national and international institutions, such as IPEA, World Bank, IADB and OCDE.		
Expected capacity building	Working knowledge in projects that require IBGE microdata, more specifically Innovation Survey (PINTEC-IBGE), Manufacturing Annual Survey (PIA-IBGE) and Labor Census data of all former Brazilian workers (RAIS-MTE)		
Contribution to project	- Coordinating and reporting on the design/implementation of the projects' policy engagement - Working on the research as a team member by implementing the empirical strategy and writing the paper		

Team member #3

Name	Age	Sex (M, F)	Highest degree/diploma
Synthia Kariny Silva de Santana	29	F	Doctorate
Training and experience	Research on projects related to firm level productivity, growth and innovation. Consultant for impact evaluation to public institutes in Brazil such as IPEA and CONDEPE/FIDEM.		
Expected capacity building	Researcher on the determinants of innovation activities in Brazilian firms.		
Contribution to project	- Coordinating and reporting on the design/implementation of the projects' policy engagement - Working on the research as a team member by implementing the empirical strategy and writing the paper		

Team member #4

Name	Age	Sex (M, F)	Highest degree/diploma
Leandro Justino Pereira Veloso	26	M	Master's Degree
Training and experience	Provided consultancy to IADB and has experience as a research fellow working with numerous project on IPEA and USP.		
Expected capacity building	Have knowledge working with huge datasets of firms and labor levels and applying econometric methods for cross-section and panel structure of data.		
Contribution to project	- Working on the research as a team member by implementing the empirical strategy and writing the paper - Coding and optimizing on the implementation of the projects.		

2.2. List of past, current or pending (non-PEP) projects in related areas involving team members, including resulting publications (If any)

Name funding institution, title of project and related publications, list of team members involved.

Name of funding institutions	Title of projects and related publications (link)	Team member(s) involved
IADB	*Title: Obstacles to Innovation*	*Filipe Lage de Sousa*
	Publication (reference): Under implementation	
IADB	*Title: Competition and Innovation in the Caribbean Region*	*Filipe Lage de Sousa*
	Publication (reference): IADB book	
World Bank	*Title: Productivity-Boosting Agglomeration Economies are Underleveraged*	*Filipe Lage de Sousa*
	Publication (reference): WB publication	
GDN / JICA	*Title: Management and Productivity*	*Filipe Lage de Sousa*
	Publication (reference): Under implementation	
World Bank	*Title: ICT use, innovation, and productivity: evidence from Sub-Saharan Africa*	*Filipe Lage de Sousa*
	Publication (reference): Background paper for the WDR 2016 and WB Discussion Paper	
Brazilian Development Bank	*Title: Relaxing Credit Constraints in Emerging Economies: The impact of public loans on the performance of Brazilian firms*	*Filipe Lage de Sousa*
	Publication (reference): CEP Discussion Paper	
Brazilian Development Bank	*Title: Credit Scarcity in Developing Countries: An Empirical Investigation Using Brazilian Firm-Level Data*	*Filipe Lage de Sousa*
	Publication (reference): Peer-reviewed publication	
UNESCAP	*Title: Obstacles to Productivity in Asia and Pacific Region: Finance Reigns*	*Filipe Lage de Sousa*
	Publication (reference): UNESCAP Discussion Paper	
ENCE	*Title: Women Participation in Rio de Janeiro Labor Market*	*Glaucia E. de S. Ferreira*
	Publication (reference): Under graduation Monograph	

PUC-RJ	Title: Tree Structured Smooth Transition Model STAR-TREE for Wind Power Forecasting	Glaucia E. de S. Ferreira
	Publication (reference): M.Sc. Dissertation	
IPEA	Title: Productivity in Brazil: performance and determinants	Glaucia E. de S. Ferreira and Leandro Justino P. Veloso
	Publication (reference): IPEA Book	
IADB	Title: Learning from Productive Development Agencies in Brazil: Policies for Technological Innovation	Synthia Kariny Silva de Santana
	Publication (reference): IDB WORKING PAPER SERIES N° IDB-WP-765	
IPEA	Title: Brazil in the Global Value Chains	Synthia Kariny Silva de Santana
	Publication (reference): Discussion papers - TD n°2114; TD n° 2034.	
IPEA	Title: Good Law and Productivity of Brazilian Industrial Firms	Leandro Justino P. Veloso
	Publication (reference): IPEA Book	

2.3. List of past or current PEP-supported projects involving team members, including resulting publications

We have never been supported by PEP

Project code (e.g. PMMA-12345)	Title of project and related external (non-PEP) publications, if any	Team member(s) involved
	Title:	
	Publication (reference):	
	Title:	
	Publication (reference):	
	Title:	
	Publication (reference):	
	Title:	
	Publication (reference):	
	Title:	
	Publication (reference):	
	Title:	
	Publication (reference):	

SECTION III – RESEARCH

3.1. Literature review (max 1000 to 1500 words)

Explain specific gaps in existing literature that your research aims to fill. You might want to explain whether or not this question has been addressed before in this context (including key references), and if so, what you wish to achieve (in addition) by examining the question again?

Literature on economic growth is huge and we will focus on productivity growth due to its relevance for development as explained previously when describing our research questions. Syverson (2011), for instance, provides a literature review on what determines productivity and concludes that innovation is one of the key internal drivers for productivity growth. If innovation is one of the main drivers for productivity growth, the subsequent question is: how innovation can be fostered? Different angles have been investigated, such as competition by Aghion et al (2005), but literature started to focus on the diversity among firm's employees, see Diaz-Garcia et al (2013), Frosch (2011) and Østergaard et al (2011). According to these papers, diversity plays an important role in firm's innovation, especially in terms of gender as observed in Diaz-Garcia et al (2005) and Østergaard et al (2011), but limited impact in terms of age, see Østergaard et al (2011) and Frosch (2011). In general, diversification of the workforce can be understood on a wide range of dimensions such as gender, age, ethnicity, culture and skills required to develop work activities. We will focus on the first two of them.

As evidenced by Frosch (2011), most studies use cross-section data and therefore results should be interpreted with care. Dataset available for this research enable us to create a panel of firms to investigate this issue, which enables us to address the shortcomings of cross-section data. At this point we must address the virtues of firm-level panel data when analyzing how worker's diversity can foster innovation and productivity growth. The longitudinal analysis stands out from the others (cross-section or time-series data) for its ability to control the heterogeneity among firms by estimating individual effects, thus isolating the effects of explanatory variables not measured by the researcher (see Baltagi (2008) and Hsiao (2003) for further details). In fact, it provides a greater degree of information, joint with a greater degree of variability, which results in more degrees of freedom, less collinearity among the variables and higher efficiency. We can benefit from the linkage of databases on same tax identifier to follow the firms over time on a wide range of characteristics regarding labor market, innovation and production, allowing us making inferences about the dynamics of change on firm-level. Additionally, the previous literature assumes individual's characteristics, such as gender, age and educational status, as isolated facts. In other words, they consider gender and age as explained variables independent to their educational level. In our research, we aim to address this issue by considering these characteristics according to workers educational level. For instance, we will create different groups of workers educational level to understand how diversity of age and gender in these different educational cohorts are able to influence innovation and eventually productivity. As for different educational levels, there is a literature on distinct ways to classify Brazilian workers based on the existent datasets, which basically uses workers' occupation and their school achievements to create a measure of their total educational level, see Araújo,

Cavalcante and Alves (2009) as well as Araújo, Kannebley, Maffioli and Stucchi (2014) for further details. Using this information jointly with others provided by the innovation survey, such as the number of employees dedicated to R&D activities, we will be able to explore this issue extensively. Moreover, as evidenced by Crespi and Zuninga (2012), expenditures on innovation as a whole are much more relevant than just R&D in developing countries because firms in such parts of the world tend to adopt existing technologies rather than cutting-edge technologies. Therefore, we aim to investigate the effects of worker's diversity on innovation expenditures as a whole, not only on R&D expenditures.

Oaxaca (1973) states that culture, tradition and overt discrimination restrict women participation in the labor force both in terms of adverse distribution among workers as pay differences, even within the same occupation. In Brazil, male-female labor market participation as well as wage differentials is covered by a variety of studies and demonstrate that education (Scorzafave and Menezes-Filho, 2001), fertility rate (Cunha and Vasconcelos, 2016) and cohorts-related or cultural issues (Becker, 1991; Wajnman and Rios-Neto, 1994) played a key role in the growth of female activity rates in recent years.

Gompers and Wang (2017) document this pattern on women's participation in venture capital firms and as founders of venture capital-backed start-ups as an approach for the impact of diversity on innovation. They find that the persistent lack of female in innovation activities is not driven by a lack of supply of highly trained women as the representation of female in advanced science and engineering degrees has been substantially higher for the past decades.

According to Aghazadeh (2004), diversity is an essential resource for improving organizational performance. Thus, in addition to women participation on the labor market, an alternative proxy for labor diversity is the workforce age dimension. The lack of professional education in Brazil is one of the main problems that make it difficult for young people to get their first job. Even with less technical skills and experience, younger people can be an asset to firm as long as they can improve experience by on-the-job training, for example. Also, the new demographic composition can be challenging for entrepreneurs due to high life expectancy and skills required on each occupation. Age diversity can be leveraged to foster innovation by firms by its larger knowledge pool, as pointed out by Backes-Gellner and Veen (2013). They find that age diversity within a company's workforce affects company productivity if and only if a company engages in creative rather than routine tasks.

Thus, strengthening women market participation and age diversity at workplace can led to more innovation that ultimately can be translated into productivity growth. However, to the best of our knowledge, questions about how the female insertion and age diversity in the labor market promotes skills redistribution and drive innovation at the firm-level have not yet been concretely addressed, particularly in Brazil.

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3.2. **Methodology** (max 1200 to 1600 words)

Presentation of the specific techniques that will be used to answer the research questions and how exactly they will be used to do so.

- Explain whether you will use a particular technique normally used in other contexts or whether you intend to extend a particular method and how you will do so.
- Explain if these methods have already been used in the context you are interested in (including key references).
- **For PMMA (microeconomic analysis) proposals only**: In case the proposed methodology aims to empirically estimate a causal relationship, explain potential sources of endogeneity in the context of your research, and how the proposed technique(s) would allow the identification of the relevant parameters.

Our first step in our empirical strategy comprehends on how to measure workers' diversity. According to Harrison and Klein (2007), three dimensions should be considered when measuring workers' diversity, which are: separation; variety; and disparity. The number of categories of a certain attribute is considered as a variety. For instance, the number of different educational levels in a firm can be considered as a variety of that economic agent. Separation is how the shares of the specific categories are distributed in the group. For instance, two firms with the same number of workers' educational level (for example, 2 levels: literate or non-literate), but they are distributed differently (while one might have 3 literate workers and 2 illiterate, the other might have 2 literate workers and 3 illiterate). The last dimension is the disparity, which refers to the distance between the outer boundaries of the categories within one characteristic. For instance, in our previous example, the first firm has a higher educational level than the second. We will follow the methodology proposed by Østergaard et al (2011), which measures workers' diversity in two ways. For categorical variables, we will use the Shannon-Weaver entropy index, while for continuous variables, we could use either standard error and the coefficient of variation.

Before detailing our empirical methodology on how diversity may impact innovation, we want to highlight what kind of innovation is considered as well as its nuance in each type. Our classification of innovation follows the Oslo Manual, which provides guidelines on this issue to all countries interested in understanding such complex issue. Not only the Brazilian innovation survey (PINTEC) follows this manual, but also other countries and multilateral institutions (see the Spanish and World Bank innovation survey's questionnaires for comparison). The manual classify innovation into three main types: product innovation; process innovation; and organization innovation. These are considered three different innovation outcomes, which can be explained by different types of determinants. Moreover, these innovation surveys provide further information on these innovation outcomes developed by the firm. For instance, a follow up question on product innovation is made on its novelty, which is whether this invention can be considered a new product to the firm, to the domestic market or even to the international market. Therefore, we will be able to explore how diversity might affect different levels of innovation, which can be classified from incremental (new to the firm) to completely radical (new to the international market). Having said that, we will explore all the feasible information provided by an innovation survey which follows an international protocol and is comparable to others from developed countries as well as from multilateral institutions. In order to estimate the impact of workers' diversity on innovation, and consequently on firms' productivity, we follow

the literature and adopt the framework developed by the Crepon-Douguet-Mairesse (CDM) model (Crepon et al., 1998). The framework is grounded on the idea that firms invest in knowledge inputs, which can be transformed into innovation outputs according to the efficiency of their innovation function. Subsequently, these innovation outputs impact productivity contingent on the capacity of firms to transform innovation outputs into improvements in product characteristics and efficiency. As a result, the CDM model requires the estimation of three stages: determinants of innovation inputs, the knowledge or innovation production function and the productivity equation.

In the CDM model, investments in R&D are the main innovation inputs. However, innovation in developing countries are much more assimilation and adaptation of existent technologies rather than disruptive new technologies, as argued in Crespi and Zuniga (2012). Therefore, our measure of innovation input comprehends the total expenditure in innovation, which includes acquisition of machinery, patents, trademarks and others. The determinants of knowledge input intensity can be characterized by three sets of factors that are commonly found in the literature, as suggested in Crepon et al. (1998), such as firm characteristics, the firm's market conditions, and the investment climate.[1] Firm characteristics include worker's diversity which is our main investigated characteristic in this research. Our knowledge investment intensity variable presents a substantial number of zero values and missing observations, which requires the use of a particular econometric technique to estimate their determinants. In order to tackle this issue, Tobit model by maximum likelihood is our chosen approach. Our measure denoted by E_{it} from a firm i in time t are related to another latent variable E^*_{it} such that

$E_{it} = E^*_{it} = β'_2x_{2it} + ε_{2it}$ when $β'_2x_{2it} + ε_{2it} > 0$ and zero otherwise   (1)

In any particular year t, x_{2t} corresponds to the exogenous explanatory variables that determine knowledge inputs. Disturbances for equations (1) for our input innovation measure are assumed to be *iid* normally distributed (Question 1).

Innovation inputs generate innovation outputs. According to Mohnen and Hall (2013), continuous variables present more robust results than dummies for different types of innovation. Therefore, how much of innovation represented in firms' annual turnover appears to be more appropriate than any dummy for innovation. Therefore, we focus our estimation on this particular measure and our innovation output can be defined as:

$Innov_{it} = β_3'X_{3it} + ε_{3it}$ (2)

Where X_3 include innovation input variable from equation (1) as well as other determinants of innovation outputs. As when estimating the determinants of innovation input, innovation outcomes present a large number of zeros since most firms are not able to innovate and even among those innovating, some might not be able to see the results of their new products in their sales. As in the innovation inputs determinants, we make use of the Tobit model by maximum likelihood. In terms of defining the set of explanatory variables used, we follow the literature on the determinants of innovation outcomes (Question 2).

The final stage to estimate the impact of innovation on firm performance is to derive the productivity equation. We approximate productivity using a Cobb-Douglas function where sales

[1] See Cohen and Levin (1989).

(Y) are a function of capital (K), labor (L) and innovation outputs (H), summarized in formula (3) below:

$$Y_{it} = f(H_{it}, K_{it}, L_{it})$$

$$Y_{it} = H_{it}^{\delta} K_{it}^{\alpha} L_{it}^{\beta} \tag{3}$$

$$(Y_{it} / L_{it}) = (H_{it}^{\delta} K_{it}^{\alpha} L_{it}^{\beta} / L_{it}) (L_{it}^{\alpha} / L_{it}^{\alpha})$$

Transforming equation 3 in logarithm form and adding sector controls (Z_{it}), we have

$$\log (Y_{it} / L_{it}) = \delta_0 + \delta \log (H_{it}) + \alpha \log (K_{it} / L_{it}) + (\beta+\alpha-1) \log(L_{it}) + \theta Z_{it} + \varepsilon_{it} \tag{4}$$

By estimating equation (4), we are aware of the potential simultaneity between innovation outputs and performance (Question 3). Thus, the main challenge to estimate the CDM model is the potential reverse causality between knowledge inputs and innovation outcomes - i.e. more innovation can trigger more knowledge investments - and between knowledge outcomes and performance – i.e. the most productive firms are more successful in innovation. Originally, CDM model was estimated by asymptotic least squares (ALS) in which all equations are estimated jointly. However, most of the literature has opted for a sequential approach, where predicted values of endogenous variables are included in the estimation of the next equation, such as Griffith et al (2006). Although these two strategies are not exactly the same, Hall et al (2009) and Musolesi and Huiban (2010) do not find a great difference when estimating it by maximum likelihood approach or by a sequential IV estimation approach if endogeneity and selection are treated properly. Therefore, we will follow the literature and estimate the model by both strategies, ALS and Sequential, yet the last one using bootstrap to provide a more accurate estimation of the standard errors.

In order to evaluate the structural change, we will evaluate these issues at sector level and decompose the productivity growth at sector level (Question 4).

3.3. Data requirements and sources (max 400 to 700 words)

This is a critical part of the proposal. The key issue is to explain the reason for the choice of your particular databases. You must establish that they are ideal for the question you wish to address and that you have or will have access to these data before your project begins. Please consult the "Guide for designing a research project proposals" for more detail.

One of the main information source will be the firm-level data from the innovation survey, named PINTEC by its acronym in Portuguese, from the Brazilian Statistical Institute (*Instituto Brasileiro de Geografia e Estatistica* – IBGE). It is a sample survey, inspired by the Oslo Manual from OCDE, which means that it is comparable to other similar surveys worldwide, see PINTEC (2014) and/or other years for further details. There were already six waves of this survey (1998-2000, 2001-2003, 2003-2005, 2006-2008, 2009-2011 and 2012-2014), which enables us to construct a panel of firms (probably unbalanced panel) over an extended period, including recession and expansion of the Brazilian economy. PINTEC provides a diverse range of information on innovation, including in product and process innovation and the qualification of workers.

The other relevant dataset is the Annual Census of Brazilian formal workers in Brazil elaborated by the Ministry of Labor, named RAIS. This dataset covers all active firms in Brazil, regardless of their size, and provide further information of the qualification of the workforce from each firm. It includes specific information of the workers, such as gender, age, educational status and others. This dataset is available from late 80's until the most recent year (currently 2014).

An additional survey from IBGE, Annual Manufacturing Survey (PIA), is also available to create additional controls for this investigation and it will also be requested. PIA is available annually from 1996 until the most recent year available (currently 2014). PIA is compatible to PINTEC in methodological terms, such as same sector classification and both cover the whole Brazilian manufacturing sector.

Possibility to merge PIA, RAIS and PINTEC is envisaged in their submission rules for accessing the microdata from IBGE and it is usually requested by researchers interested in using the firm-level dataset for their projects. All three publications have the tax id for all firms, which enables researchers to merge both datasets.

In total, we are able to create a panel of more than 30 thousand firms per year using these three datasets. All the four researchers in this project has intense experience in dealing with these datasets. See our resumes for further information on the qualification of these four researchers in this regard.

SECTION IV – POLICY ENGAGEMENT

4.1. Policy relevance

4.1.1. Describe policy context and needs

Describe the specific policy issues or needs that your research aims to address; how your potential outcomes and findings may be used in policy making? Please be as precise as possible, indicating specific current or prospective policies and the specific contributions your research would make.

Also, justify timing of your research in terms of policy and socioeconomic needs and context – e.g. reference to existing, planned or potential policies at the national, regional or local level; specific political context; international examples of similar policy problems or solutions, etc.

The Brazilian economy has benefited substantially by the change in the terms of trade after the entrance of China in the international market. The abundance of resources provided opportunities to expand government support in different areas, especially on innovation. Indeed, the volume of government support to foster innovation in Brazil has increased substantially in the last years. These government policies have also reached a different spectrum of firms, as there were new financial tools to support innovation. One example is the creation of new credit lines in 2008 designed to support exclusively innovation by the Brazilian Development Bank (BNDES is its acronym in Portuguese). The surge of these policies was influenced by impact evaluation assessments of BNDES policies initiated by Lage de Sousa & Ottaviano (2008), which shows limited impact of previous financial support on productivity due to lower emphasis of

innovation in the supported projects. Additionally, there was also a shift of government policies towards more support for innovation in the private sector rather than government support for innovation activities made in universities and research centers, see Canêdo-Pinheiro (2013) for further discussion. As an illustration, 6.4% of Brazilian manufacturing firms have received government support to innovate in 2005, while the same share reached 14.5% in 2014, as shown in Canêdo-Pinheiro & Figueiredo (2017).

On one hand, the existent literature shows that, in general terms, these government policies to support innovation in the private sector worked reasonable well. There is evidence that, everything else constant, the public support increased the innovative efforts in the private sector, not merely crowded out other sources of private funding to innovation. On the other hand, other evidence shows that these policies were not so successful. For example, outcomes in terms of new products and processes do not correspond to the quantity of financial resources allocated in this period. After an initial increment between 2005 and 2008, the percentage of innovative firms in the manufacturing sector reduced from 38.4% in 2008 to 36.3% in 2014. Similar trend was observed for expenditures on innovation (such as its share in terms of sales).

Given the lack of success in increasing innovation outputs, it is important to understand whether worker's diversity is able to promote more innovation, and eventually productivity growth. Brazilian government, especially its development bank named BNDES, is seeking for micro evidence on which type of interventions are more prominent to promote productivity growth. Therefore, we believe that our research may provide some evidence in order to focus the government policies towards more successful projects, thus enhancing development in a country struggling to overcome the middle-income trap.

4.1.2. Consultations to date

List the consultations that you have had with potential research users (e.g. policy makers or stakeholders) and that have helped define your research question, and/or informed you of the specific policy context described above.

For each institution consulted, please:
- List key (individual) representatives who participated in the consultation
- Describe the main outcome(s) of the consultation (feedback, inputs, etc.)
-

Name of institution/organization #1	Inter-American Development Bank
List the key representative involved in consultations (names and titles/positions)	
– Dr. Jose Claudio Linhares Pires / Lead Economist	
Describe main outcomes of consultation – feedback or inputs received	
Dr. Pires found our research proposal interesting and adequate for the region investigated. Despite being focus on Brazil, he believes that this type of investigation might be relevant for the whole Latin America and any other developing countries, in which women and young workers struggle in the labor market. He suggested to investigate this issue at sector level, since the effect of diversity might have distinct impacts in each sector. Moreover, he told us that he might put us in	

contact with Brazilian government institutions, such as the Brazilian Innovation Agency (FINEP) and the Brazilian Development Bank (BNDES), since they might be interested in our research.

4.2. Engagement strategy

4.2.1. Identify target audiences

Identify potential users of your research findings – institutions/organizations that may use your findings to inform, advise or influence policy or other relevant decision-making processes. Please explain why you believe these institutions/organizations are the most important potential users of your research, to inform relevant development/policy decisions.

Name of institution/organization #1	Brazilian Development Bank (BNDES)
Explain relevance of this user to inform key decisions	
The Brazilian Development Bank has a diverse range of financial support for private sector. Among their financial support, some of them are designed for innovation. Therefore, micro evidence on where innovation is more efficient provides inputs for not only selecting more successful projects but also defining an special treatment for firms which promotes gender diversity in their economic activities.	

Name of institution/organization #2	Brazilian Innovation Agency (FINEP)
Explain relevance of this user to inform key decisions	
FINEP provides loans and grants for innovation not only in Brazilian research institutions but also to private sector. Their financial support are instrumental tools to foster innovation in the Brazilian economy, especially radical innovations. Our findings might provide insights on which projects supported by this government institution might perform better and perhaps change its conditions for projects aiming to promote gender and/or age diversity in innovation activities.	

Name of institution/organization #3	Brazilian Statistical Institute (IBGE)
Explain relevance of this user to inform key decisions	
IBGE provides a diverse range of information from the Brazilian economy and society. In terms of economic surveys, the institutions provide the innovation and manufacturing surveys which does not contemplate any gender information. If our work provides robust evidence that gender diversity might be relevant for innovation, the institution might add a topic on gender in their questionnaire.	

4.2.2. Define outreach and engagement strategy

How, <u>from proposal design to the dissemination of your research results</u>, will you consult and communicate with these users to both gather their inputs and keep them informed of your project, in order to increase chances of research uptake?

> While implementing the project, we aim to discuss it with Brazilian government organizations, such as IPEA and IBGE in order to obtain feedback as well as any other relevant stakeholder.

4.2.3. Outline your preliminary dissemination strategy

Outline your <u>preliminary</u> dissemination strategy (channels, tools, events, audiences, etc.).

Note that PEP expects grantees to disseminate information about their research work and (expected) outcomes throughout the project cycle, and not only after publication.

> We aim to present our research at economic conferences held annually in Brazil (ANPEC/SBE) as well as in Latin American (LACEA) and in any other conference/workshop which we believe can have some policy implication.
>
> Additionally, we want to present our results to institutions which provide support to innovative activities not only with Brazilian institutions, such as FINEP and BNDES, but also multilateral institutions such as the World Bank and the Inter-American Development Bank.

SECTION V – OTHER CONSIDERATIONS

5.1. Describe any ethical, social, gender or environmental issues or risks that should be noted in relation to your proposed research project.

Our team is composed by individuals who were able to advance their education despite their non-favored economic and social condition. Children of Brazilian afro-descendants and coming from the suburbs of main cities where the low-income families live, our team could achieve success in our careers due to dedication and determination. Our parents do not have a college degree and we never had any family financial support for our careers. Therefore, by choosing a team composed by those more vulnerable in the Brazilian society, PEP will not only select a research project with quality content but also providing opportunities to those that had only few in their lives.

5.2. References and plagiarism:

Applicants should be very careful to avoid any appearance of plagiarism. Any text of five or more consecutive words that is borrowed from another source should be carefully contained between quotation marks with a reference to the source (including page number) immediately following the quotation. It is essential that we be able to distinguish what you have written yourself from what you have borrowed from elsewhere.

Note also that copying large extracts (such as several paragraphs) from other texts is not a good practice, and is usually unacceptable. For a fuller description of plagiarism, please refer, for example, to the following website:

- http://writing.yalecollege.yale.edu/advice-students/using-sources/understanding-and-avoiding-plagiarism

PEP will be using a software program to detect cases of plagiarism.